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AIR QUALITY AND URBAN DEVELOPMENT

GUIDELINES FOR ASSESSING IMPACTS OF PROJECTS AND PLANS



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Guidelines for Assessing Impacts of Project and Plans

November 1985

Prepared by the Planning Division of the
Bay Area Air Quality Management District

939 Ellis Street

San Francisco, CA 94109

This document is intended to serve as a guide for those who prepare or evaluate air quality impact analyses for plans and projects in the San Francisco Bay Area. The GUIDELINES include information on legal requirements, methods of analysis, regional meteorology and air quality, along with BAAQMD rules, plans, and administrative procedures. The format is looseleaf, so that the various sections can be updated as required. Copies and updates are available from the BAAQMD Public Information Office at (415) 771-6000, extension 210. Questions on content may be addressed to BAAQMD Planners at (415) 771-6000, extension 280.

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Bay Area Air Quality Management District

AIR QUALITY and URBAN DEVELOPMENT Guidelines for Assessing Impacts of Project and Plans

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I. INTRODUCTION

A. General Comments

These GUIDELINES are intended to inform users about the reasons for undertaking air quality analyses for projects and plans, the methods of analysis, and possible mitigation measures to reduce adverse impacts.

Development decisions of cities, counties and other public bodies, as well as those of private developers, can have major impacts on the air quality of metropolitan regions. These decisions may be expressed as approvals, disapprovals, or modifications of areawide plans or specific, site-related projects. In recognition of this influence, the California Environmental Quality Act (CEQA) requires that local public "lead agencies" assess and consider the air quality effects, as well as other environmental impacts, of proposed plans and projects of potential environmental significance. This they must do before exercising whatever discretionary approval power they may have.

As part of the process and prior to their local government certification, Environmental Impact Reports and related documents are to be referred, for review and comment, to the public agency which has jurisdiction over air quality matters. For the nine counties and more than 90 cities and other lead agencies in the San Francisco Bay Area Air Basin, the relevant air quality agency is the Bay Area Air Quality Management District (BAAQMD). This applies to environmental documents under the National Environmental Policy Act (NEPA) as well as CEQA. The BAAQMD reviews environmental documents and also exercises permit control for "direct sources" of air contaminants--e.g. industrial uses, power plants, refineries, dump sites, dry-cleaning plants, gasoline stations. BAAQMD environmental document review, but not permit control, also takes place for "indirect sources"--land uses and facilities which usually do not emit a significant amount of contaminants but which attract or generate motor vehicle trips, with resulting pollution. Where there is potential for attracting vehicles at such volumes that their emissions may cause significant pollution to degrade air quality, it is particularly important that the air quality impact be estimated. It is in this area that local planning bodies can make critical decisions which affect their long-term future environment and that of their neighboring communities.

These GUIDELINES do include methods for making preliminary estimates of direct source emissions and concentrations of pollutants. But the principal focus is on determining and mitigating indirect source emissions and concentrations, based on a prior analysis of traffic generation. The critical importance of analysis and mitigation of the impacts of emissions from motor vehicles can be understood from the following information.

In the San Francisco Bay Area, motor vehicle emissions account for 83% of the ambient air carbon monoxide and almost 43% of the man-made reactive organics--hydrocarbons which react with nitrogen oxides in sunlight to form ozone. Motor vehicle emissions also make up about 46% of the air-borne particulates--dust and other solids resuspended from roads by wheel movement, as well as particles emitted from engine exhaust and tire wear. Carbon

monoxide, ozone and particulates are the air contaminants of critical importance in the Bay Area for attaining, and maintaining, adequate air quality as set forth in federal and State health based standards. In addition, nitrogen oxides (56% motor vehicle caused) are significant because of their role in ozone formation and their contribution to reduction of visibility and acid deposition. Thus air quality in the Bay Area is, to a large extent, a function of the traffic generated which is, in turn, a function of local planners' decisions regarding development. Discretionary factors include size, location, design and service infrastructure of major housing developments, shopping centers, office complexes, industrial uses and other private and public facilities.

These GUIDELINES have been formulated to assist the planning and environmental review offices of cities, counties and other lead agencies; developers and consultants who often prepare the actual drafts of environmental assessment documents; environmental and civic organizations; and citizens who may want to understand how air quality analysis is undertaken and what types of mitigations may be appropriate. The GUIDELINES are based on the most recent information and methods available. Some of the methods have been purposely simplified so that it becomes possible to undertake analysis for smaller and relatively simple projects without the use of complex computer models. For large and/or complex projects and plans it may still be preferable to utilize less generalized input and more complex and complete models as are referenced in the GUIDELINES.

This text is meant to replace the previous GUIDELINES FOR AIR QUALITY ANALYSIS OF PROJECTS, published by the BAAQMD in June 1975. The new text not only has more current information; it is also broader in scope--going beyond the almost exclusive attention, paid in the previous version, to models for estimating contaminant concentrations. The new text is also designed to accommodate future findings and new concerns; the format is "loose-leaf" so that obsolete pages can be easily extracted and new pages added as they are produced. Portions will be replaced as new information becomes available on such matters as revised emission factors for the Bay Area motor vehicle fleet. Whole new sections may be added to cover emerging and future concerns about topics such as acid rain, toxic air emissions, transport of contaminants between regions and sub-regions, and integrated environmental management.

The recommendations in these GUIDELINES should be viewed as minimum considerations for air quality analysis. A lead agency or a development applicant may substitute more sophisticated models, more precise input data, innovative mitigation measures and/or other features. The BAAQMD encourages creative approaches to analysis and mitigation in planning for air quality improvement.

B. Use of the GUIDELINES:

The basic purpose of these GUIDELINES, then, is to inform users about the essential reasons and methods for undertaking air quality analysis and for mitigating negative impacts of projects and plans. It includes information which is usable for formulating environmental impact reports and statements and other environmental documents, and for incorporating air quality concerns at early planning stages; e.g., in city and county general plans and specific area plans. In addition to this chapter I, Introduction, the following format

is used:

Chapter II, CEQA: explains the process relationship between these GUIDELINES and the California Environmental Quality Act. The chapter also extracts relevant passages of the CEQA statute, CEQA Guidelines and definitions.

Chapter III, Thresholds: lists the minimum project sizes, of the most common kinds of land uses and facilities found in the Bay Area, which are recommended for air quality analysis by local lead agencies and for forwarding of documents to BAAQMD for review. In unusual cases, even smaller projects than the sizes listed may warrant environmental assessment. This would be the case if there is reason to believe that air contaminant emission rates would be higher than usual; that toxic emissions, unusual contaminants, or odors may result; or that more than 2000 motor vehicle trips per day would be generated by the use or facility.

Chapter IV, Sensitive Receptors, Health Effects, Toxics and Acid Deposition: describes the purposes of air quality standards and their relationship to the health of the population. It defines "sensitive receptor" in terms of categories of persons known to be especially sensitive to ill effects of air pollutants and in terms of facilities where such pollution is found. Effects on crops and materials are also mentioned. The chapter also discusses known toxic air contaminants and industrial sources of polluting and odorous substances. Land use conflicts which produce air quality problems are also discussed. Acid rain and acid fog are briefly described.

Chapter V, Environmental Data Base: is meant to provide local planners with essential background information about Bay Area air quality and the potential for problems. Background levels of pollutants are discussed and mapped. This material is most useful for the "environmental setting" section of EIRs. The chapter discusses and charts recent air quality trends and relevant meteorological conditions.

Chapter VI, Emission Rates: This chapter discusses proportions of air contaminants attributable to various activities. Tables and charts demonstrate the role of transportation--mostly motor vehicles--compared to other categories of emission sources. It provides data which becomes input to the models described in the following chapter. Tables indicate emission levels that can be expected from motor vehicles, stationary sources (factories and the like) and construction.

Chapter VII, Impact Analysis: is the heart of these GUIDELINES. It describes relatively simple calculations and models that can be used to predict the total emissions and ambient air concentrations of contaminants. The simplified models described are usually adequate for analyzing the impacts of smaller projects under worst-case standardized conditions. In the case of larger projects (category C thresholds or larger in Table IX-B-3), the models can be used as "screening devices" in order to obtain a preliminary estimate of the likelihood that standards will be exceeded. If the outputs reveal such a possibility, more complex models may be called for, such as the California Air Resources Board's URBEMIS model, to more precisely estimate motor vehicle emissions and CalTrans's CALINE3 or CALINE4 models to estimate resulting concentrations.

In addition to "line source" models for estimating air contaminant concentrations along road links, at intersections and at mid-blocks from motor vehicles--this GUIDELINES chapter also describes "point source" models for predicting concentrations of air contaminants from factories and other stationary sources. An elevated terrain model is given for sites of complex topography. Transport of reactive pollutants is also discussed.

Chapter VIII, Significance: defines the meaning of a "significant air quality impact." It explains how to compare emission levels calculated and concentration levels derived through use of the models with federal and State ambient air quality standards, and the meaning of such a comparison.

Chapter IX, Mitigation Measures: explains when projects should be mitigated and describes a number of potentially applicable measures appropriate to various situations. It is a key chapter in the new GUIDELINES. It is through the application of mitigation measures to projects that negative impacts are reduced, negative air pollution effects are minimized, and the Bay Area's air quality is conserved. In addition to this chapter of the GUIDELINES, local environmental protection and planning officials, developers, and consultants are referred to two relevant complementary publications: TRAFFIC MITIGATION REFERENCE GUIDE, by the Metropolitan Transportation Commission (1984) and GUIDELINES FOR AIR QUALITY IMPACT ASSESSMENT, Section V, by the California Air Resources Board (1985).

Chapter X, Plan Relationships: briefly discusses the relationship between the responsibilities of local governments in the areas of General Plans and Specific Area Plans, on the one hand, the air quality considerations on the other. The basic philosophy conveyed is that it is almost always more efficient and effective to pre-plan for air quality conservation, especially in county-wide or regional subarea General Plans, than to rely on ex post facto environmental impact assessments of projects. Thus, treatment of air quality issues in plans is favored over exclusive reliance on project-by-project impact review. A more detailed discussion and suggestions regarding such planning may be found in the above cited Metropolitan Transportation Commission publication, especially the chapter on "Implementation Strategies for Local Governments." An air quality element, while not required under State of California General Plan Guidelines, could fit logically into a city and, especially, county conservation element, circulation element or special, optional element. Within these GUIDELINES there is also a discussion of the relationship to local planning of the BAY AREA AIR QUALITY PLAN, authored by the BAAQMD, Association of Bay Area Governments and MTC.

II. PERTINENT CEQA REQUIREMENTS

A. Introduction

These GUIDELINES are intended to facilitate air quality review and analysis of local projects and plans. Attainment of National Ambient Air Quality Standards (NAAQS) by 1987 and their ongoing maintenance as Bay Area growth continues will be significantly influenced by land use decisions made at the city and county level. Reduction of vehicle trips generated by new development through trip-reduction ordinances, conditions of development, or other methods can benefit air quality as well as minimizing future traffic congestion.

The California Environmental Quality Act (CEQA) requires evaluation of all environmental impacts and consideration of feasible methods of reducing or eliminating any significant adverse impacts. This document highlights certain sections of CEQA and the "CEQA Guidelines" which deserve particular attention from an air quality standpoint. Review of the full text of the highlighted sections would be of value in understanding the legislative intent and recent court decisions which may affect application of this law. (Omission of a section from the following listing does not imply its lack of relevance, but simply means no special reference was deemed necessary here.)

B. Summary of CEQA Provisions

1. The CEQA Statute

Sec. 21000(d): This legislative declaration recognizes the need "to identify any critical thresholds for the health and safety of the people" and the need for action to prevent reaching such thresholds (which may include air quality standards.)

Sec. 21001 (b): Declares that it is State policy to provide the people with clean air. cf. CEQA Guidelines Sec. 15011(b).

Sec. 21002: Legislative declaration that "feasible alternatives and feasible mitigation measures" should be adopted where a project has significant air quality or other environmental effects.

Sec. 21065.5: "Environment" is defined to include the air and other conditions "within the area which will be affected by a proposed project." cf. CEQA Guidelines Sec. 15360.

Sec. 21081: Specifies findings which must be made by the lead agency where an Environmental Impact Report (EIR) identifies significant air pollution or other effects of a project. cf. CEQA Guidelines Sec. 15091.

Sec. 21083(b): Requires the CEQA Guidelines to include criteria for determining "significant effect on the environment", including air and other impacts which are "individually limited but cumulatively considerable." cf. CEQA Guidelines Sec. 15065(c).

Sec. 21153: Requires lead agencies preparing EIR's to consult with "each responsible agency and any public agency which has jurisdiction by law with respect to the project." The BAAQMD is a "responsible agency" where it has permit authority and an "agency with jurisdiction by law" in other cases where air quality may be affected--see CEQA Guidelines Sec. 15029.6. cf. CEQA Guidelines Sec. 15086 ff.

2. The CEQA Guidelines

Sec. 15064(b), 15358: Requires consideration of secondary as well as primary consequences of a project, for example, an impact on air resources resulting from population growth facilitated by a new sewer treatment plant.

Sec. 15092: Where significant air or other effects are not mitigated, the lead agency must approve a "statement of overriding considerations."

Sec. 15125: An EIR "shall discuss any inconsistencies between the proposed project and applicable general plans and regional plans" specifically including the regional Air Quality Maintenance Plan.

Sec. 1526(a): "The EIR shall also analyse any significant effects the project might cause by bringing development and people into the area affected", e.g. a subdivision over a fault line of near an odorous industry or dump.

Sec. 15131, 15355: Defines "cumulative impacts" which may include air quality impacts, and describes required treatment including level of detail and necessary elements.

Sec. 15162: Defines a "Subsequent EIR" to include cases where "Substantial changes occur with respect to the circumstances under which a project is undertaken, such as a substantial deterioration in the air quality where the project will be located.

Sec. 15169: Defines a "Master Environmental Assessment" as an approach to organize information and identify impacts on a regional or area basis.

Sec. 15207: Provides that certain projects, based on specified threshold sizes, shall be deemed of "statewide, regional or areawide significance." EIR's or Negative Declarations on such projects must be submitted to the State Clearinghouse and should be submitted to the areawide Council of Governments, i.e. ABAG in the Bay Area.

Sec. 15329: Exempts cogeneration equipment of 50 megawatts or less capacity at existing facilities where certain conditions are met.

Sec. 15384: Allows "tiering"--where a general EIR is followed by a narrower or site-specific EIR, the later EIR need not repeat the broader issues previously covered. Tiering is allowed only if the later proposal includes "all relevant mitigation measures adopted in response to the EIR on the program, plan, or policy."

Appendix G: With respect to air quality, "a project will normally have a significant impact on the environment if it will" . . . "Violate any air quality standard, contribute substantially to an existing or projected air quality violation, or expose sensitive receptors to substantial pollutant concentrations."

Appendix H: Environmental Information Form, to be completed by applicant (suggestive only).

Appendix I: Environmental Checklist Form, to be completed by Lead Agency (suggestive only).

C. Environmental Documents

Notice of Preparation. Applies only with respect to "responsible agencies", e.g. the BAAQMD in an air quality permit context.

Initial Study. Preliminary overview. Should involve air quality factors for projects which equal or exceed threshold sizes (Chapter III of these GUIDELINES).

Negative Declaration. No significant adverse air impact expected.

Mitigated Negative Declaration. Initial Study indicates possible significant effect but applicant revises plans or makes an enforceable commitment to mitigate.

EIR. Project may have a significant adverse impact on air quality.

Program EIR. Covers a large project or series of projects to be carried out over time.

Special situations -- see CEQA Guidelines Secs. 15181-15184:

Redevelopment project. May be treated as in a Program EIR--i.e., a single document for the entire project, except for localized impacts which are not evident until a later point in time.

Urbanized areas. See CEQA Guidelines.

Specific Plan. See CEQA Guidelines.

Community Plan/Zoning. See CEQA Guidelines

General Plan EIR: See Chapter X of these GUIDELINES.

III. THRESHOLD LEVELS FOR PROJECT SUBMISSION AND REVIEW

The District Planning Division reviews and comments on significant air quality effects of projects which are the subject of environmental documents--Notices of Preparation, Draft/Final Environmental Impact Reports, Negative Declarations, Initial Studies, and other environmental and planning documents. The procedures requiring review by BAAQMD are contained in the California Environmental Quality Act (CEQA), the subject of Chapter II of the GUIDELINES. CEQA also contains provisions for review of projects by State agencies, including the California Air Resources Board, which reviews projects of statewide, regional or areawide significance. Threshold levels for ARB review are contained in CEQA Guidelines Section 1516.6, (State of California, Office of Planning and Research), and documents are submitted through the State Clearinghouse.

Projects for review by BAAQMD are submitted directly to the Planning Division. It is recommended that projects or plans be submitted when they exceed one or more of the threshold levels indicated in Table III-A-1. Projects smaller than the threshold levels should be submitted if there are special circumstances--e.g., when cumulative impacts cause an area to exceed or approach ambient air quality standards; when a combination of uses in one project approaches threshold levels; proximity to sensitive receptors (residences, schools, hospitals, nursing homes, playgrounds, park and recreation facilities), proximity to other pollutant sources (industrial sources emitting odorous or hazardous compounds, such as sewage treatment plants, chemical and refining operations, etc.); where toxic, unusual or odorous contaminants will be emitted by the project; or unusual land-use or facility conflict situations.

The following thresholds represent size or activity levels which produce land-use-related mobile source emissions approximately equal to the BAAQMD New Source Review thresholds for stationary sources--550 lbs/day for carbon monoxide. For each land use category, a specific trip end generation rate and average trip length were determined for the San Francisco Bay Area. Emissions were calculated with 1985 Bay Area composite emission factors for mobile sources at an average speed of 25 mph. Some rounding of values and adjustments were made to calculated threshold levels.

The levels indicated in the table are the minimum size projects--among the more common types being developed in the Bay Area--which could produce air quality problems. Therefore any environmental documents for plans and projects, at these levels or greater should be submitted to BAAQMD for review. Relatedly, the threshold levels may be interpreted, as being of potential significance. Therefore as Lead Agencies, they may want to require that EIRs--or at least "Focused EIRs" covering air quality impacts--be prepared for plans and projects which equal or exceed these levels. Where two or more projects are contemplated in close proximity, the cumulative impact may be critical. This impact may be analyzed in any or all of the environmental documents for the individual projects, or in a single "master" environmental assessment for the entire area.

Larger projects--those which equal or exceed the "Category C" threshold levels in Table IX-B-3--are deemed to be even more likely to generate motor vehicle emissions which exceed CO standards. They warrant more detail analysis through the use of more complex models, as explained in Chapter VII.

TABLE III-A-1. CALCULATED THRESHOLDS FOR SUBMISSION OF ENVIRONMENTAL DOCUMENTS TO BAAQMD -- FOR SELECTED LAND USE CATEGORIES.

Land Use Category	Size Unit	Trip Generation Rate (T/SU)	Avg Trip Length (miles)	Size Equiv to 550 lb CO/day	Threshold Levels (Rounding & Judgment)
<u>Housing</u>					
Single Family	dwelt	10	6.2	194 units	200 units
Apartments	unit	5.7	6.2	336 units	300 units
<u>Parking</u>	space	6	6.2	274 spaces	250 spaces
<u>Shopping Center</u>					
Regional	1,000 ft ²	40	5	58,000 ft ²	60,000 ft ²
Neighborhood	floor	86	2	70,000 ft ²	(or 6 acres
Indiv. Store	area	48	3.7	67,000 ft ²	of land area)
<u>Industry*</u>					
Undifferentiated	acre	79	9.6	16 acres	
Mass Production	acre	93	9.6	13 acres	15 acres
Indus. Park	acre	64	9.6	20 acres	
Administration	acre	60	9.6	21 acres	20 acres
Warehouse	acre	81	6.6	22 acres	
Res. & Devel.	acre	31	9.6	40 acres	40 acres
<u>Office Bldg.</u>	1,000 ft ²	15	6.2	126,000 ft ²	100,000 ft ²
Gov't Bldg.	1,000 ft(2)	65	6.2	30,000 ft ²	30,000 ft ²
<u>Motel</u>	unit	10	5.4	221 units	200 units
<u>Restaurant</u>	seat	3	5.3	749 seats	700 seats
Fast-food	employee	75	3.7	43 employees	40 employees
Drive-in	1k ft ²	553	5.2	4,200 ft ²	4,000 ft ²
<u>Theater</u>	seat	2.5	5.3	898 seats	900 seats

Any facility attracting or generating:

1937 motor vehicle trips/day
(969 vehicles, in and out)

2000 motor trips/day
(1000 vehicles, in and out)

*NOTE: It is appropriate to prepare an air quality impact assessment and to submit to BAAQMD environmental documents prepared for:

- o all industrial and other sources with direct emissions of air contaminants which approach or exceed the BAAQMD thresholds for requiring Best Available Control Technology (BACT). See Regulation 2-2-301 for detailed listing.
- o all airports, ports, major road and other transportation projects; sports stadiums;
- o governmental actions affecting more than 50 acres;
- o smaller projects under conditions discussed on page III-1 paragraph two.

IV. SENSITIVE RECEPTORS, HEALTH EFFECTS, TOXICS AND ACID DEPOSITION

A. Criteria Pollutants and Derivation of Air Quality Standards

Smoke, dust, and various chemical compounds were recognized years ago as air pollutants. Among those whose effects have been studied and documented are: carbon monoxide (CO), photochemical ozone (O₃), sulfur dioxide (SO₂), nitrogen dioxide (NO₂), suspended particulate matter (PM), and lead (Pb). Ambient air quality standards have been set for these and other pollutants by State and/or federal agencies. Acceptable concentration levels are chosen after careful review of all available data on health and other effects. Pollutants subject to national ambient standards are sometimes referred to as "criteria pollutants" because EPA publishes criteria documents to justify the choice of standards.

A principal purpose of these GUIDELINES is to provide methodologies for describing air quality impacts in terms related directly or indirectly to the ambient air quality standards. What are these standards and what is their underlying rationale? Ambient air quality standards are an indicator of acceptable "community" air quality. Ambient air is the air which people breathe, outside of buildings, as they go about their normal activities. Pollutant concentration levels below the ambient standards have not been found to cause health effects or property damage. Pollutant levels above the standards begin to cause noticeable health effects, especially the aggravation of respiratory problems in sensitive individuals. These standards should be distinguished from several other kinds of air standards or measurements: standards for acceptable air quality in the workplace, administered by OSHA; emissions limits for specific point sources of air pollution (e.g., industrial plants), enforced by BAAQMD under its regulations; and episode criteria for exceptionally high ambient air pollution levels posing an immediate danger to health, which can trigger a series of general warnings and emergency measures by the air quality district.

Ambient air quality standards were established in California starting in 1969 pursuant to the Mulford-Carrell Act, and at the federal level beginning after passage of the 1970 Clean Air Act Amendments. The federal standards are supposed to be attained by 1987 and maintained thereafter; the California standards do not have a specific attainment date.

The air quality standards are designed to protect public health and welfare in several broad ways:

First, to protect the most sensitive members of the population from chronic and acute health effects, particularly the causation or aggravation of chronic cardio-respiratory diseases including bronchitis, emphysema, asthma and restrictive ventilatory disease;

Second, to protect the population at large from adverse but transitory effects including irritation of eyes and respiratory tract; headaches, chest pains and coughing; unpleasant odors; and impaired visibility;

Third, to protect society from damage to crops and plants (e.g., grapes, flowers, leafy vegetables) and materials (e.g., paint, rubber, synthetics.)

Clearly the most serious of these is the first. While community air pollution is just one factor in chronic respiratory disease--others include smoking and occupational exposure--scientists believe that over a long period of exposure, say 20 to 30 years, this relatively low-level exposure to pollution is a significant factor. Ambient air quality standards are based on the best scientific evidence available, and usually include a safety margin because of the uncertainties involved.

The criteria air pollutants for which ambient air quality standards exist, have been the principal focus of air pollution control efforts to date. Because these pollutants are few in number and frequently present in the ambient air, they are relatively easy to study, document and, theoretically at least, regulate.

B. Toxic Air Pollutants

Another group of substances known as toxic (or hazardous) air pollutants is receiving increasing attention as a subject of public concern and regulation. These pollutants may be highly injurious, even in small quantities. Because there are many toxic pollutants (measuring in the hundreds or even thousands) and they are relatively uncommon, they generally have not gone through the lengthy and costly process needed to set ambient air quality standards. Of known toxics or chemicals highly suspected of being so, those currently being studied by EPA and/or ARB are listed in Table IV-B-1.

The Clean Air Act provides for the designation of hazardous air pollutants (NESHAPS) with accompanying emission limits. To date five such pollutants have been designated--asbestos, beryllium, mercury, vinyl chloride and benzene--and these are now regulated by the BAAQMD. The California Legislature established a comprehensive program for the study, identification, and control of toxic air pollutants -- AB 1807 (1983). Two specific designations--benzene and ethylene dibromide--have occurred under this program as of this writing. Finally, the BAAQMD can control air toxics under its general "nuisance" power, as authorized by State Health and Safety Code, Section 41700 (now incorporated as BAAQMD Regulation 1-301).

TABLE IV-B-1. POTENTIALLY TOXIC CHEMICALS - 1985

(under study by EPA and/or ARB)

Acetaldehyde	Ethylene Oxide
Acrolein	Formaldehyde
Acrylonitrile	Hexachlorocyclopentadiene
Allyl Chloride	Lead
Arsenic	Maleic Anhydride
Asbestos ¹	Manganese
Benzene ^{1,3}	Mercury ¹
Benzyl Chloride	Methyl Bromide
Beryllium ¹	
Cadmium	Nickel
Carbon Tetrachloride	Nitrobenzene
Chlorobenzene	Nitrosomorpholine
Chlorofluorocarbon (FC-113)	Phenol
Chloroform	Phosgene
Chloroprene	
Chromium	Polychlorinated Biphenyls
Coke Oven Emissions	Propylene Oxide
o-,m-,p-Cresol	
Dichloromethane	Radionuclides ²
p-Dichlorobenzene	Toluene
Dialkyl Nitrosamines	1,1,1 Trichlorethane
Dimethyl Nitrosamine	Tetrachloroethylene
1,4-Dioxane	Trichloroethylene
Dioxin	Vinyl Chloride ¹
Epichlorohydrin	Vinylidene Chloride
Ethylene Dibromide ^{1,3}	o,m,p-Xylene
Ethylene Dichloride	

1-National Emissions Standards for Hazardous Air Pollutants (NESHAPS), for certain sources, have been promulgated by EPA, and BAAQMD has adopted Rules for them.

2-An NESHAPS promulgated by EPA but no applicable rules by BAAQMD.

3-Declared to be toxic under the Tanner bill process - AB1807

Of course any potential hazardous emissions from projects should be discussed and analyzed, and mitigations should be spelled out, in the environmental assessment document. For major sources of toxics--those which exceed BACT threshold levels as listed in Table VIII-A-1, ("non-criteria pollutants")--a

risk assessment analysis should also be carried out. (Later additions to these GUIDELINES will discuss toxics more fully, as capability to measure and cope is extended.)

C. Health Effects Summary

The following chart summarizes some of the adverse effects of major air pollutants, both "criteria" and toxic varieties.

<u>Air Pollutant</u>	<u>Adverse Effects</u>
Ozone	- eye irritation - respiratory function impairment
Carbon Monoxide	- impairment of oxygen transport in the bloodstream, increase of carboxyhemoglobin - aggravation of cardiovascular disease - impairment of central nervous system functions - fatigue, headache, confusion, dizziness - can be fatal in the case of very high concentrations in enclosed places
Sulfur Dioxide	- aggravation of chronic obstruction lung disease - increased risk of acute and chronic respiratory illness
Nitrogen Dioxide	- risk of acute and chronic respiratory disease
Sulfates	- decreased lung function - aggravation of asthmatic symptoms, cardio-pulmonary disease
Total Suspended Particulate	- increased risk of chronic respiratory disease with long exposure - altered lung function in children - with SO₂, may produce acute illness
PM ₁₀	- particulate matter 10 microns or less in size which may be inhaled, and possibly lodge in and/or irritate the lungs
Lead	- impairment of blood function and nerve construction - behavioral and learning problems in children
Asbestos	- malignancies of the lung, pleura and peritoneum
Beryllium	- progressive granulomatous disease of the lung
Mercury	- central nervous system and renal toxicity
Vinyl Chloride	- angiosarcoma of the liver - possibly other cancers - possible effects on human reproduction

D. Sensitive Receptors

The most important reason for air quality standards, and for concern about air toxics, is the likelihood of adverse health effects to the most sensitive members of the population. The term "sensitive receptors" can refer both to the population groups concerned and to the facilities (land use categories) where such groups are likely to reside or spend a substantial amount of time.

Local projects and plans can affect sensitive receptors in two basic ways: by causing or contributing to air quality problems (such as exceedances of an air quality standard within a certain area) and by locating sensitive receptors within an area where air quality problems may occur. Local planners should be alert to the possibility that sensitive receptors in the project vicinity, or in the project itself, may be adversely affected by approval and construction of a project.

Sensitive receptor population groups include children, the elderly, the acutely ill, and the chronically ill--especially those with cardio-respiratory diseases. In terms of land uses, the relevant categories are linked to the receptor groups as follows:

<u>Sensitive Receptor Group</u>	<u>Land Use Category</u>
children	residences schools playgrounds child care centers
elderly	residences retirement homes convalescent homes
acutely ill	hospitals, clinics
chronically ill	convalescent homes

E. Land-Use Conflicts and Sensitive Receptors

In many locations, existing or proposed industrial sources are located near sensitive receptor locations (housing, schools, hospitals, etc.). This often results in land use conflicts as residents and users of the facilities are exposed to industrial air pollutants. When siting new housing, or other uses for sensitive members of the population, location of industrial sources and their impacts should be considered. Conversely, future industrial development should consider the existence of sensitive receptors in the vicinity.

BAAQMD has specific regulations to control pollutants for which ambient air quality standards have been set (SO₂, H₂S, particulates, etc.). Many regulations are specific by industry (e.g., oil refineries, paint manufacturing and electronics manufacturing). In addition to those pollutants with specific limits, hazardous, odorous, or nuisance-causing

substances may be emitted by industrial sources. BAAQMD has odor and nuisance regulations which are based on the receipt and confirmation of citizen complaints. A summary of these regulations follows:

Regulation 1-301 - Public Nuisance: "No person shall discharge ... such quantities of air contaminants or other material which cause injury, detriment, nuisance or annoyance to any considerable number of persons or the public; or which endangers the comfort, repose, health or safety of any such persons or the public, or which causes, or has a natural tendency to cause, injury or damage to business or property."

Regulation 7-101 and 102 - Odorous Substances: "This Regulation places general limitations on odorous substances and specific emission limitations on certain odorous compounds ... odors (must be) perceived at or beyond the property line ... and deemed to be objectionable by the complainants in the normal course of their work, travel or residence."

Many types of industrial operations have been identified by BAAQMD enforcement and engineering staff as having a high potential for becoming the sources of odor/nuisance actions if sensitive receptors are located nearby or downwind, due to the types of materials handled and chemical compounds produced. Some examples follow:

TABLE IV-E-1. POTENTIAL ODOR/NUISANCE OPERATIONS

<u>Type of Operation</u>	<u>Contaminants/Materials Handled</u>
Sewage treatment plants	H ₂ S, chlorine, mercaptans, odors
Fiberglassing	Styrene
Cement batch plants	Cement particles, dust
Class I (chemical) dumps	Various toxic/odorous materials
Class II (garbage) dumps	Garbage odors, dust
Oil Refineries	SO ₂ , H ₂ S, particulates, hydrocarbons, mercaptans, odors
Chemical manufacturing	Various dangerous and/or odorous compounds
Power plants	SO ₂ , NO _x , particulate fallout
Rendering plants	Amines, odors
Feed lots, agricultural operations	Odors
Toxic waste dumps, transfer stations	Toxics
Electronic manufacturing	Solvents, toxic gases (arsine, phosphine)

The siting of a housing project near existing industrial sources, or of an industry near housing, may result in exposure to air contaminants and complaints of odors and nuisance where no previous odor or nuisance potential existed--because no land use conflict existed. Odor/nuisance complaints may be received even though industrial sources are meeting all applicable ambient air quality standards. Furthermore, industrial plants, sewage treatment plants and other operations listed above--even those with state-of-the-art pollution control technology--may experience short term process upsets, resulting in emission of various contaminants.

We recommend the following steps in evaluating the air pollution impacts of industrial sources on sensitive receptors when locating new projects:

- Map the project in relation to existing and planned industrial or residential uses.
- Consider wind patterns, using nearby wind rose information (see chapter on meteorology).
- Identify the percentage of time the residential (or other sensitive) uses will be downwind of the industrial sources.
- List contaminants emitted and materials handled by the industrial sources, their quantity, and their potential for becoming airborne. If exact information is not available, estimate--e.g., from similar facilities--or see estimating tables in chapter VI-B on "Emissions, Stationary Sources".
- Summarize BAAQMD violation and complaint history for existing industrial sources.
- Compare air pollution experience of similarly sited residential (sensitive) projects near industrial sources.
- If necessary, consult with BAAQMD planning staff.

TABLE IV-E-2. ODOROUS POLLUTANTS

The BAAQMD Regulation 7 also has emission limitations and dilution rate requirements for the following odor pollutants:

Dimethyl Sulfide	Phenols
Ammonia	Trimethylamine (unspecified)
Mercaptans	Other Odorous Compounds

Odor potential should be discussed in environmental assessment documents wherever relevant in a plan or project. Though not readily quantifiable, a judgment should be made and explained if there are potential odors from a project (or plan) that would extend beyond the project boundaries, or

neighboring odors that would impact the project. Appropriate mitigation measures should be applied.

F. Acid Deposition and Acid Fog

Normal unpolluted rain is mildly acidic (pH of 5.6) because of dissolved CO₂ picked up from the air. The acidity of rainfall in San Jose has been measured at a pH of 4.4. This is 15 times more acidic than unpolluted rain. Acidity of fog in San Francisco and at Point Reyes(!) has been measured at a pH of 3.5; theoretically more than 100 times more acidic than unpolluted fog.

Acid rain or acid deposition, and acid fog, can occur downwind of areas with significant emissions of sulfur dioxide and, especially here in the West, nitrogen oxides. The conversion of these gases or aerosols in the atmosphere, to sulfuric acid and nitric acid, is the primary cause of acid deposition and acid fog. Effects may be felt on the reproductive cycles of fish in streams and lakes, on soil systems and vegetation, on the deterioration of man made edifices, and potentially, on human health. However, thus far, no effects have been demonstrated in the measurements carried out in the San Francisco Bay Area.

Bay Area acidity is closely associated with nitric acid from nitrogen oxides, rather than sulfuric acid. District emission inventories--past, present and projected--indicate that the locally based potential for acid precipitation, and the even more acidic acid fog, rose to a maximum in the 1960s. Since then, both motor vehicles and stationary sources have become cleaner. Future trends depend heavily on the balance between "cleaning" of the motor vehicle fleet, on the one hand, and growth in vehicle numbers and use, on the other. Also critical is the balance between lowered emissions from industrial sources and the growth of such sources.

To learn more about the nature of acid depositon, the California State Legislature passed the Kapiloff Acid Deposition Act of 1982. An interagency working group and a scientific advisory committee have been established to assist the Air Resources Board in formulating and implementing a five-year research and monitoring program.

As this research progresses and as understanding expands and standards are set, these GUIDELINES will be updated to include material more useful to local planners, regarding acid deposition and acid fog. It is expected that we will become better able to explain what is happening in the Bay Area, how Bay Area emissions may be transported to other areas, and what may be done to mitigate any adverse impacts.

V. ENVIRONMENTAL BASE DATA

A. Introduction

This section of the GUIDELINES, providing data on emissions, meteorology and air quality in the Bay Area, serves several purposes. The section describes the environmental air quality setting as required by CEQA and as a basis for assessing the impact of local projects and plans. It provides information on air quality factors to the public and to decision-makers. It highlights trends in emissions and air quality over past years and as projected into the future. It provides a regional context for local project evaluation. Finally, the environmental base data contains specific information used in the air quality impact assessment process, notably in the form of "background" concentrations of air pollutants. Material in this section will be updated periodically.

There are two components included in environmental base data: emissions and meteorology briefly defined as follows:

Emissions are pollutants which enter the ambient air as a result of project activities. Usually the pollutants are released to the ambient (outside) air through outlets such as stacks, vents and tailpipes. Emissions are classified as "direct"--coming from stationary, point sources, generally of an industrial nature, or "fugitive" --e.g. particulates from construction or quarrying, organic fumes from storage tanks or valves, or "indirect"--coming from motor vehicle travel related to a given land use. Emissions are usually measured in terms of units of weight or mass released during a given time period (e.g., pounds per hour) or in the case of mobile sources, over a given distance traveled (e.g., grams per mile). In general, emissions from a given source are fairly constant or regular over a daily or annual cycle. They are controlled by regulations administered by the California Air Resources Board (mobile sources) and the BAAQMD (stationary sources). In addition, local "lead agencies" in the CEQA process may choose to impose mitigation measures to reduce the impact of emission sources.

Meteorology describes the atmospheric conditions--especially wind speed, wind direction, and inversions--that distribute emissions in space and time and thus affect their potential to produce harm. Depending on the meteorology, a given rate of emissions may--or may not--give rise to a serious air pollution problem. Thus meteorology is the essential link between emissions and air quality.

B. Air Quality Data

1. Carbon Monoxide Background Air Concentrations

The conventional carbon monoxide model presumes low concentration away from mobile sources. However, recent measurements in Bay Area residential neighborhoods have shown high carbon monoxide concentrations extending horizontally over several kilometers. Eight-hour CO concentrations approaching federal ambient air quality standards have been observed over wide areas in the Bay Area on stagnant winter nights. The same sites have shown one-hour CO concentrations in the 14 to 15 parts per million range during commute hours.

These data indicate the need for a new definition of background CO and concentrations to be used when modeling. Background carbon monoxide is defined as that part of the ambient CO concentration that is not attributable to traffic sources from a nearby street or intersection. Thus, during stagnant conditions, background at a site may include carbon monoxide emitted from outside the modeling area, as well as carbon monoxide emitted within the modeling area during the previous time periods.

The following maps summarize monitored carbon monoxide data within the Bay Area. The maps include data from the 17 permanent stations operated by the BAAQMD, and data from 48 sites which have been investigated in special studies by the BAAQMD and CALTRANS since 1979.

The one-hour and eight-hour 1984 maps are based on measurements taken between 1982 and 1984. Values shown for the BAAQMD permanent stations (sites with a BAAQMD in parenthesis in Table V-B-1) are the highest 2nd high from the latest 3 years. Values shown for the other sites are highest concentrations for the year mentioned. For areas of no data, value were estimated by considering topography, proximity to major traffic areas, and similarity of land use to locations with monitored data.

The one-hour and eight-hour 1987 background level maps were determined by proportionally reducing the 1984 value by the expected fractional decrease in emissions by 1987. The fractional decrease in emissions was calculated for each 5 km grid square in which a monitoring site was located.

Because the spatial variation of carbon monoxide can be significant over distances as short as hundreds of feet, these maps do not attempt to assign exact concentrations everywhere. The maps can be used to bracket the expected background carbon monoxide concentrations during worst case conditions. When reading the maps, one end of the range is specified by the highest valued isopleth that completely encompasses the site of interest. The other end of the range is plus or minus three ppm (depending upon the direction of the CO gradient). Areas outside the lowest isopleth should be considered to be 3 ppm on the one-hour maps, and 1-3 ppm on the eight-hour maps.

Fine tuning of the background carbon monoxide levels within the bracketed values should then be done by the user, by noting proximity to major roadways and to the nearest isopleth, and judging any interpolation between isopleth lines.

A list of monitoring site locations can be found in Table V-B-1. A cautionary note is that the monitoring sites were chosen so as to be representative of a large area. Thus, it is probable that there exist microscale areas with higher carbon monoxide concentrations.

Figure V-B-1. BAAQMD Ambient Air Monitoring Stations

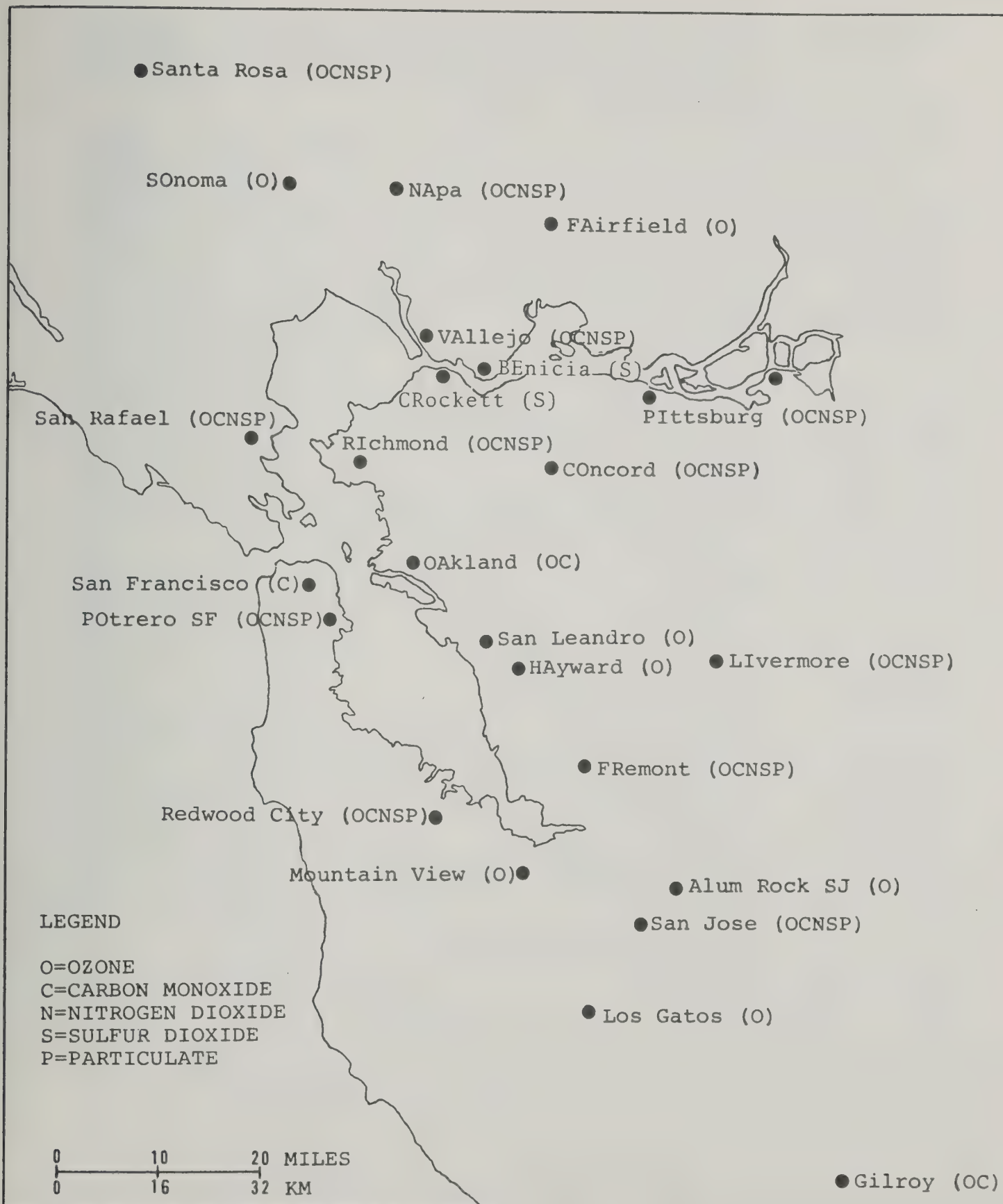


TABLE V-B-1. List of Carbon Monoxide monitoring locations and concentrations (in ppm) used to derive 1984 and 1987 CO isopleth maps. Data collected by BAAQMD and CALTRANS 1982-1984. District permanent stations are marked "(BAAQMD)".

City	Location	1983		1987	
		1-Hr	8-Hr	1-Hr	8-Hr
Bethel Island	Bethel Island Rd	3	3.0	2	2.3
Burlingame	1229 Burlingame Ave	9	7.3	7	5.7
Campbell	**Bascom Ave/Hamilton Ave	18	13.5	--	--
	More Ave between Rountree Dr/Rollard Rd	7	4.9	6	4.0
Castro Valley	Kerman Field	8	5.4	6	4.4
	Star Court	10	7.0	7	5.5
	Barnhill Lane	9	4.3	6	3.4
	Don Castro Park	9	6.5	6	5.1
	Palo Verde Rd/East Castro Valley Blvd	11	8.5	8	6.7
Concord	2975 Treat Blvd (BAAQMD)	14	5.8	12	5.1
	*Concord Sewer Plant	6	5.0	--	--
Cupertino	Homestead High School	7	3.4	5	2.6
	Bubb Rd between Stevens Cr/McClearn Rd	8	4.8	6	4.4
Danville	*Camino Tassajara/Rincon Dr	6	3.2	5	3.0
	Greenbrook Ct	5	3.2	4	3.0
Dublin	Dublin Canyon Rd/Devaney Canyon Rd	5	4.0	4	3.1
	Rampart Dr	10	8.0	8	6.2
	Amadore Valley Blvd/Brighten Dr	5	3.8	4	3.2
	Rowell Ranch	5	3.3	4	2.6
Fremont	40733 Chapel Way (BAAQMD)	10	5.1	9	4.5
Gilroy	9th/Prince Valle St (BAAQMD)	6	5.0	6	4.9
Hayward	*Broadmore Ave/Denslowe St	10	5.3	--	--
	PG&E Utility Corridor	7	3.9	6	3.1
Hercules	Route 4/Willow Ave (Maintenance Station)	6	4.0	5	3.1
Livermore	2614 Old First St (BAAQMD)	9	4.0	9	3.7
Los Altos	Eastbrook School	3	2.2	3	2.1
Los Gatos	Wedgewood Ave nr Pollard Rd	8	5.3	7	4.5
Napa	2552 Jefferson St (BAAQMD)	10	6.6	9	5.7
Oakland	822 Alice St (BAAQMD)	10	7.1	8	6.0
	822 Park Garden Center (Bellevue Ave)	12	10.8	9	8.4
	**14th/Broadway Ave	14	9.4	--	--
	**22nd/Broadway Ave	20	13.8	--	--
	34th St between San Pablo/Market St	12	8.6	8	5.8
	Lake Temescal	9	5.8	6	3.7

TABLE V-B-1. (continued)

City	Location	1983		1987	
		1-Hr	8-Hr	1-Hr	8-Hr
Palo Alto	**2865 El Camino Real near Page Hill Rd	19	11.1	--	--
Pittsburg	583 West 10th St (BAAQMD)	8	4.4	7	3.9
Redwood City	897 Barron St (BAAQMD)	13	8.0	11	6.8
Richmond	1144 13th St (BAAQMD)	8	4.0	7	3.6
	Tiller Park (Roosevelt St side)	8	4.2	6	3.4
	Plaza Circle Park	8	6.3	6	5.0
San Francisco	939 Ellis St (BAAQMD)	14	7.9	11	6.5
	900 23rd St (BAAQMD)	11	5.8	9	4.6
	**474 Geary St	15	11.5		
	**555 Battery St	15	10.1		
	100 Harrison St	13	7.8	8	5.3
San Jose	120B North 4th St (BAAQMD)	16	10.8	14	9.5
	Natural Science Building (SJSU)	12	10.3	10	8.3
	SJ Fire Station #10-Monroe St	12	10.3	10	8.3
	Frontier Village	10	8.3	9	7.2
	Skyway Dr/Houndshaven Wy	14	6.7	12	5.8
	Oak Hill Cemetary (900 ft from Rte 82)	14	5.9	12	5.1
	Aielo Rd between Lewis/Umbarger Rds	14	7.8	12	6.7
	Taylor St nr Hwy 237	10	8.3	8	7.3
	No. First St nr Hwy 237	11	7.0	9	6.1
	Rose Garden Park	12	8.2	11	7.2
	Rainbow Drive	12	5.9	11	5.4
	Cambrian Park	10	5.7	8	4.8
	Bent Ave	10	4.9	9	4.2
	Russo Ave	7	5.8	6	5.0
San Leandro	Valley Dr/Gilmore Dr	7	4.3	5	3.3
	Washington Manor Park nr Crosby St	11	5.3	10	4.1
	Cherry Grove Park between Parking Lot/Tennis Cts.	9	4.4	7	3.4
San Lorenzo	Lorenzo Manor School nr Oxford St/Richardo Ave	7	4.3	5	3.3
San Rafael	534 Fourth St	14	5.3	11	4.4
San Ramon	Bollinger Canyon Rd	4	2.3	3	2.1
Saratoga	12333 S. Saratoga Rd between Alcosta/Camino Ramon	7	4.1	6	3.4
	Saratoga Ave nr Dagmar Dr	6	4.5	5	4.1
Santa Clara	SC Chamber of Commerce	13	9.7	11	7.9
	Univ of Santa Clara nr Tosco Pavillion	13	9.1	11	7.4
	2235 Talia Ave	14	9.1	12	8.0
	Central Park	10	7.5	9	6.6
Santa Rosa	837 Fifth St (BAAQMD)	9	5.1	8	4.5
Vallejo	304 Tuolumne St (BAAQMD)	13	10.3	11	8.6

*Not a complete CO season.

**Microscale site, not used on isopleth map.

After the 1987 carbon monoxide concentration has been determined, estimates of any year to 2000 can be made using the factor in Table V-B-2. For the year desired, multiply the 1987 concentration times the appropriate factor.

TABLE V-B-2. Fraction of aggregate CO 1987 emission expected to be emitted from 1988 to 2000.

<u>Year</u>	<u>Fraction</u>
1988	0.99
1989	0.99
1990	0.98
1991	0.97
1992	0.96
1993	0.95
1994	0.95
1995	0.94
1996	0.93
1997	0.93
1998	0.92
1999	0.91
2000	0.91

*Based on estimates of carbon monoxide emissions from the Bay Area motor vehicle fleet.

2. CO Maps of Background Levels and Monitoring Sites.

The following maps show isopleths of carbon monoxide for the San Francisco Bay Area. The isopleths for 1984 were derived from neighborhood scale monitored data collected by the BAAQMD and CALTRANS from 1982-1984. Because the BAAQMD has many years of data at each site, the highest, 2nd high concentration from 1982-1984 was used. The CALTRANS data was taken from short term special studies, consequently, the highest concentration at each site was used. For areas without monitoring data, values were estimated based upon land use patterns and topography.

Carbon monoxide concentrations for the 1987 maps were estimated by multiplying 1984 concentrations for the ratio of 1987/1984 CO emissions for the appropriate 5 km grid square. The gridded emission inventories include the effects of expected growth and the California Inspection/Maintenance Program. For the one-hour map the 1987/1984 CO emissions ratio was calculated from peak-hour emissions. For the 8-hour maps, the 1987/1984 CO emissions ratio was calculated from average daily emissions.

[illegible]

Figure V-B-3. Carbon Monoxide--Eight-Hour Background Values (ppm)--1984

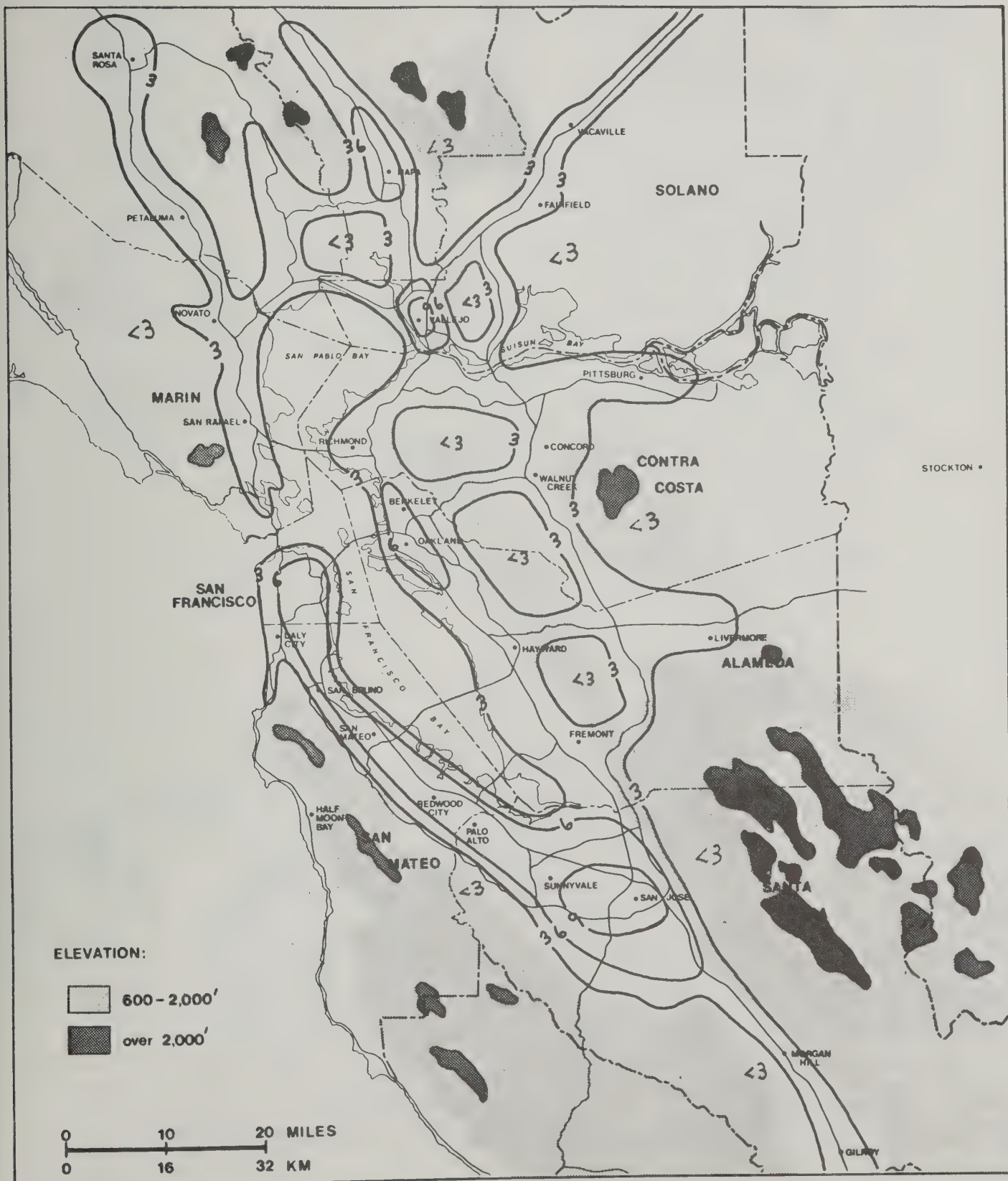
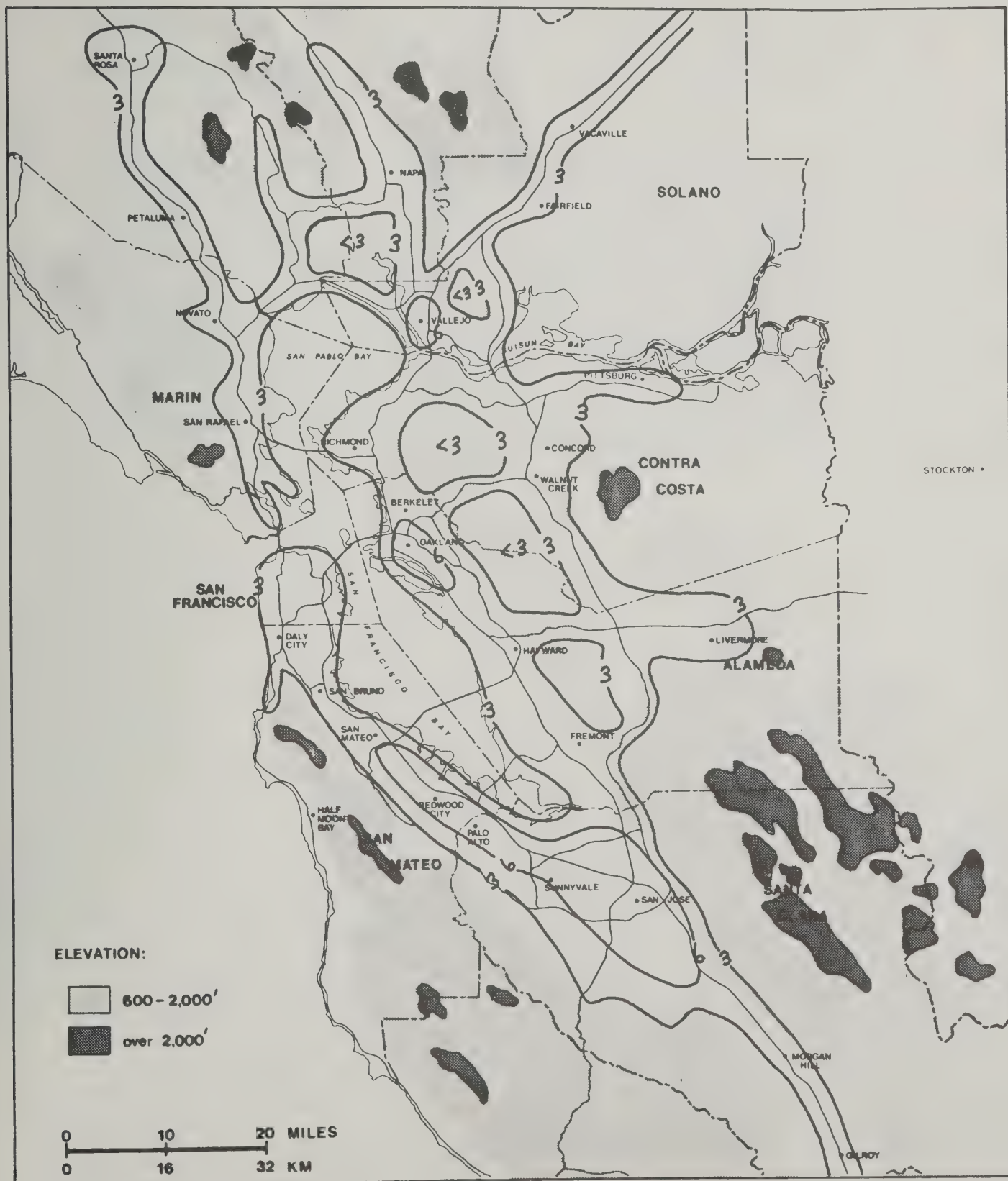


Figure V-B-5. Carbon Monoxide--Eight-Hour Background Values (ppm)--1987



3. Maps of Background Levels of Other Air Contaminants

The following maps contain isopleths of Ozone, NO₂, SO₂ and TSP. There is insufficient data at this time for fine particulate analysis. The isopleths are based on ambient concentrations collected at BAAQMD air monitoring stations from 1982-1983. These stations are considered to be representative of neighborhood scale concentrations.

For ozone and TSP, the highest 2nd high concentrations from the latest 3 years were used for analysis. This is because the Federal standards are most appropriate for these pollutants. For NO₂ and SO₂, the highest concentrations from the latest 3 years was used because the State standards are the most stringent for these pollutants.

Figure V-B-6. Ozone--One-Hour Background Values (pphm)--1984

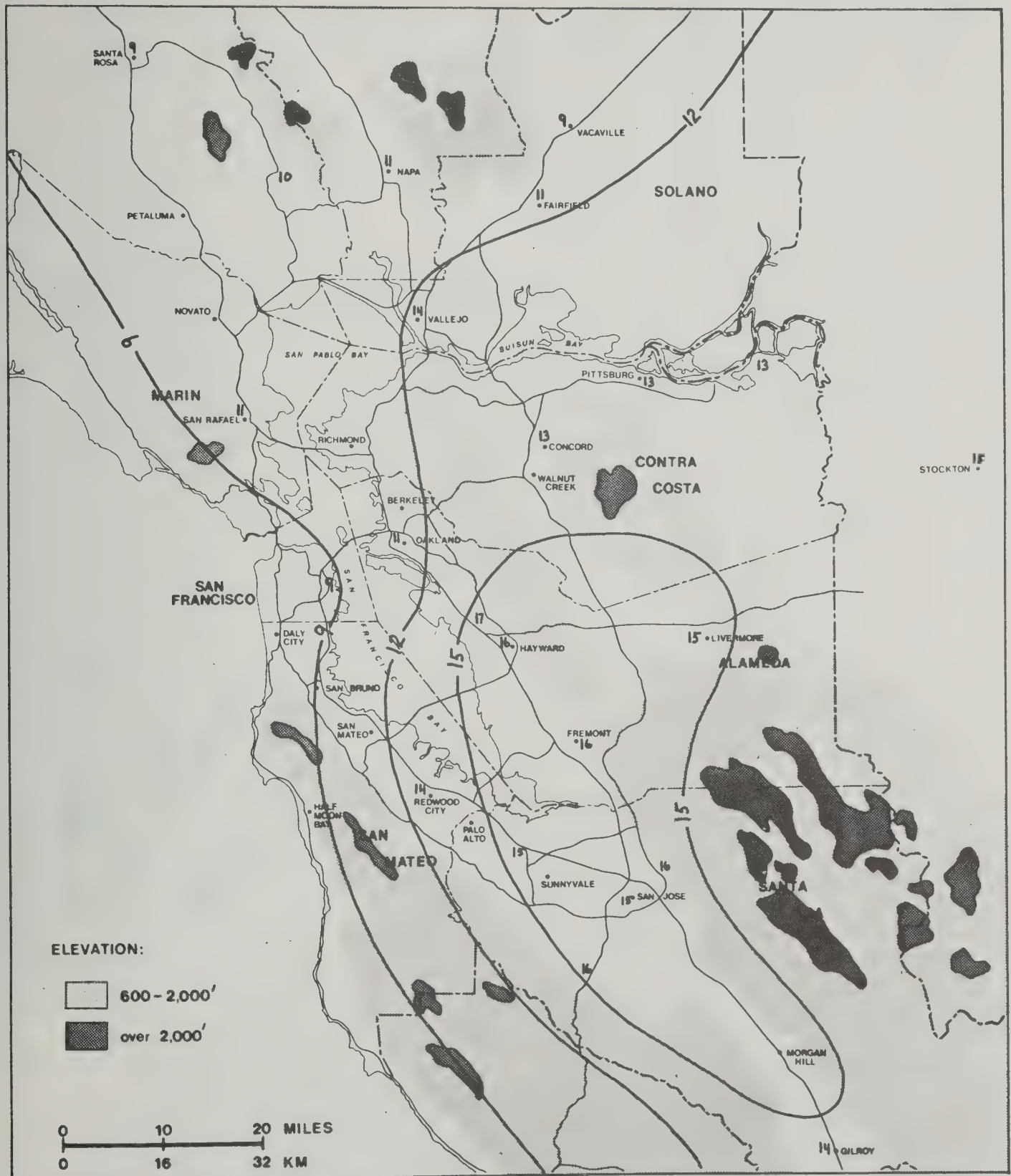


Figure V-B-7. Nitrogen Dioxide (NO_2)--One-Hour Background Values (pphm)--1984

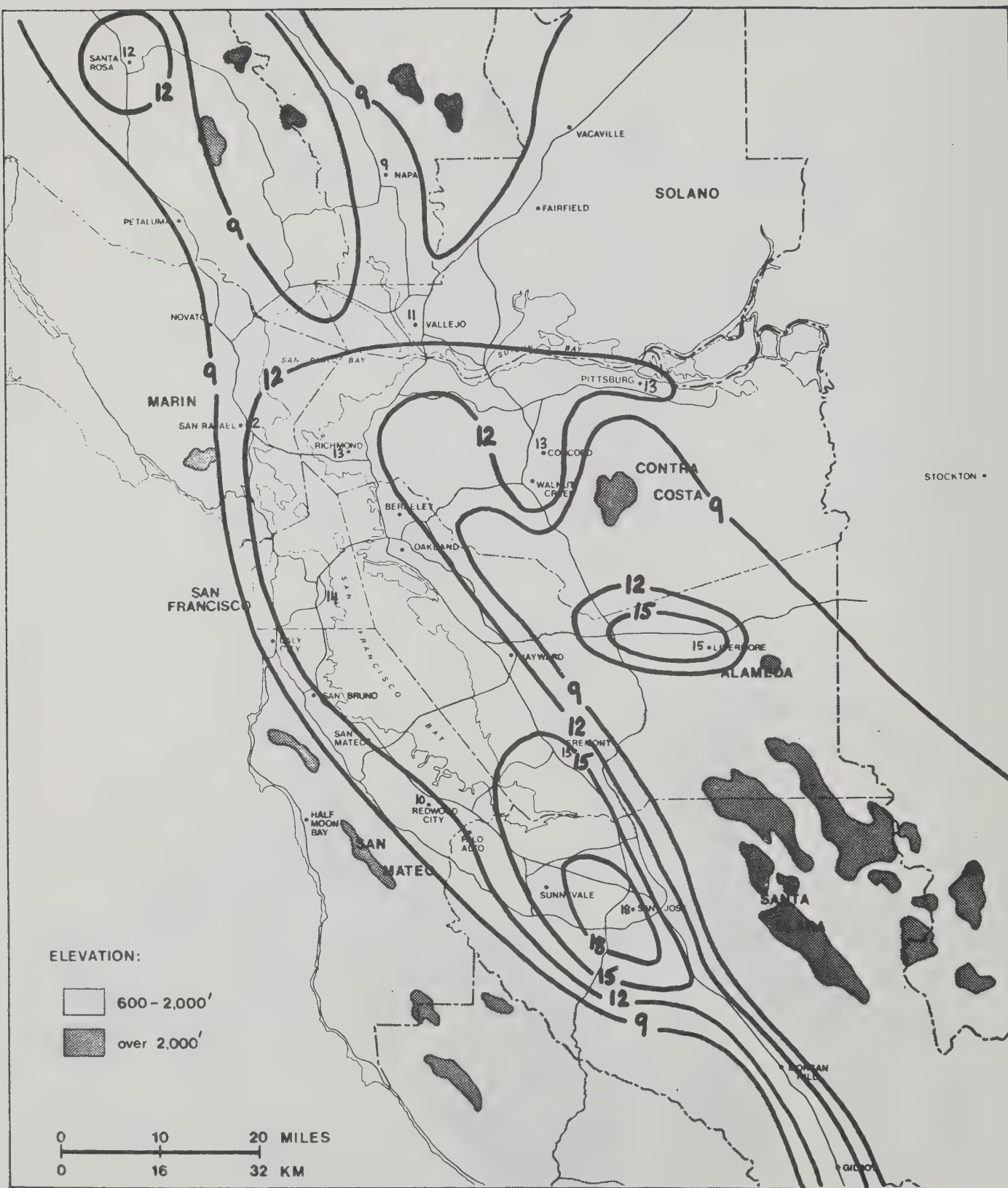


Figure V-B-8. Sulfur Dioxide (SO_2)--24-Hour Background Values (ppb)--1984

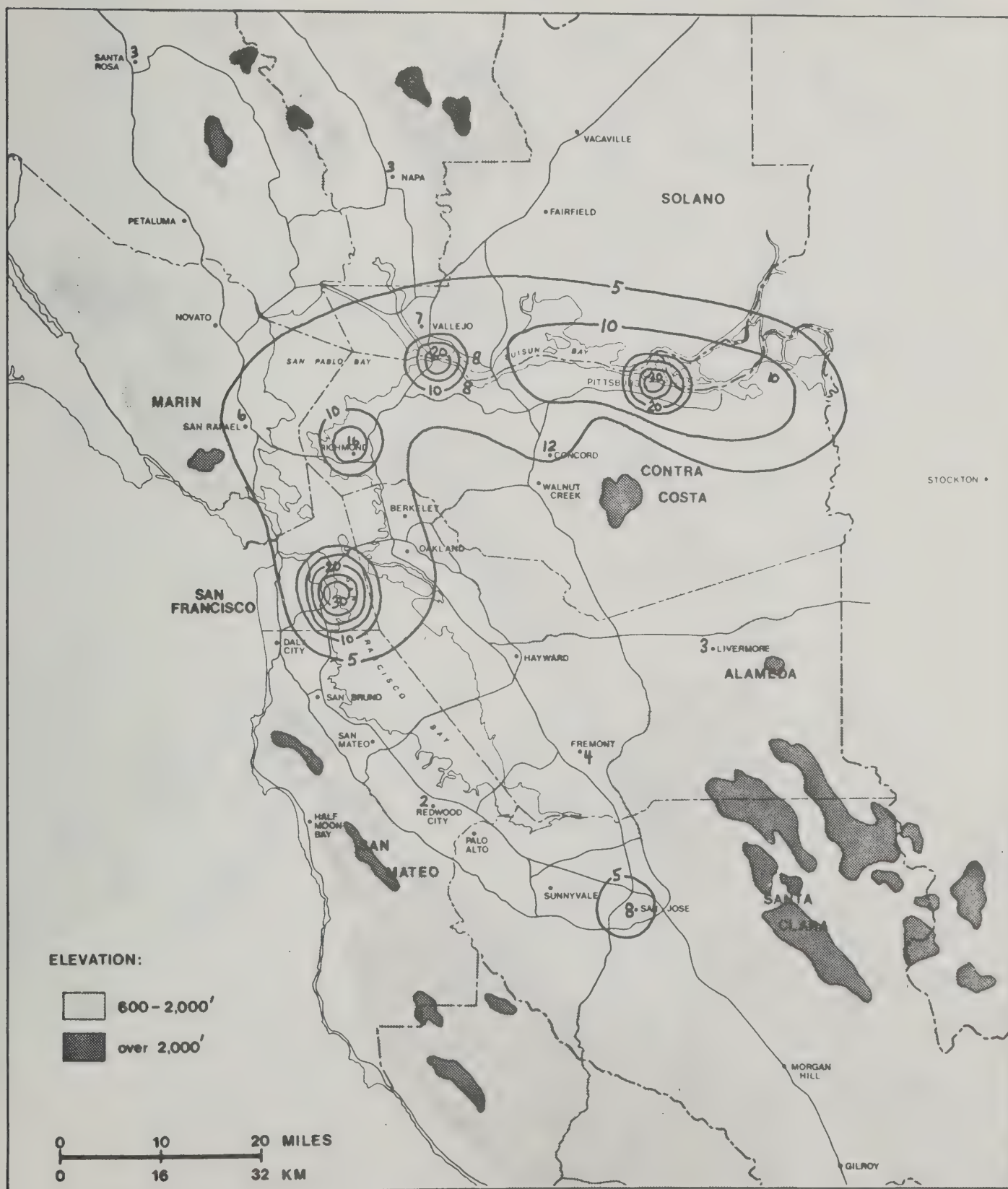
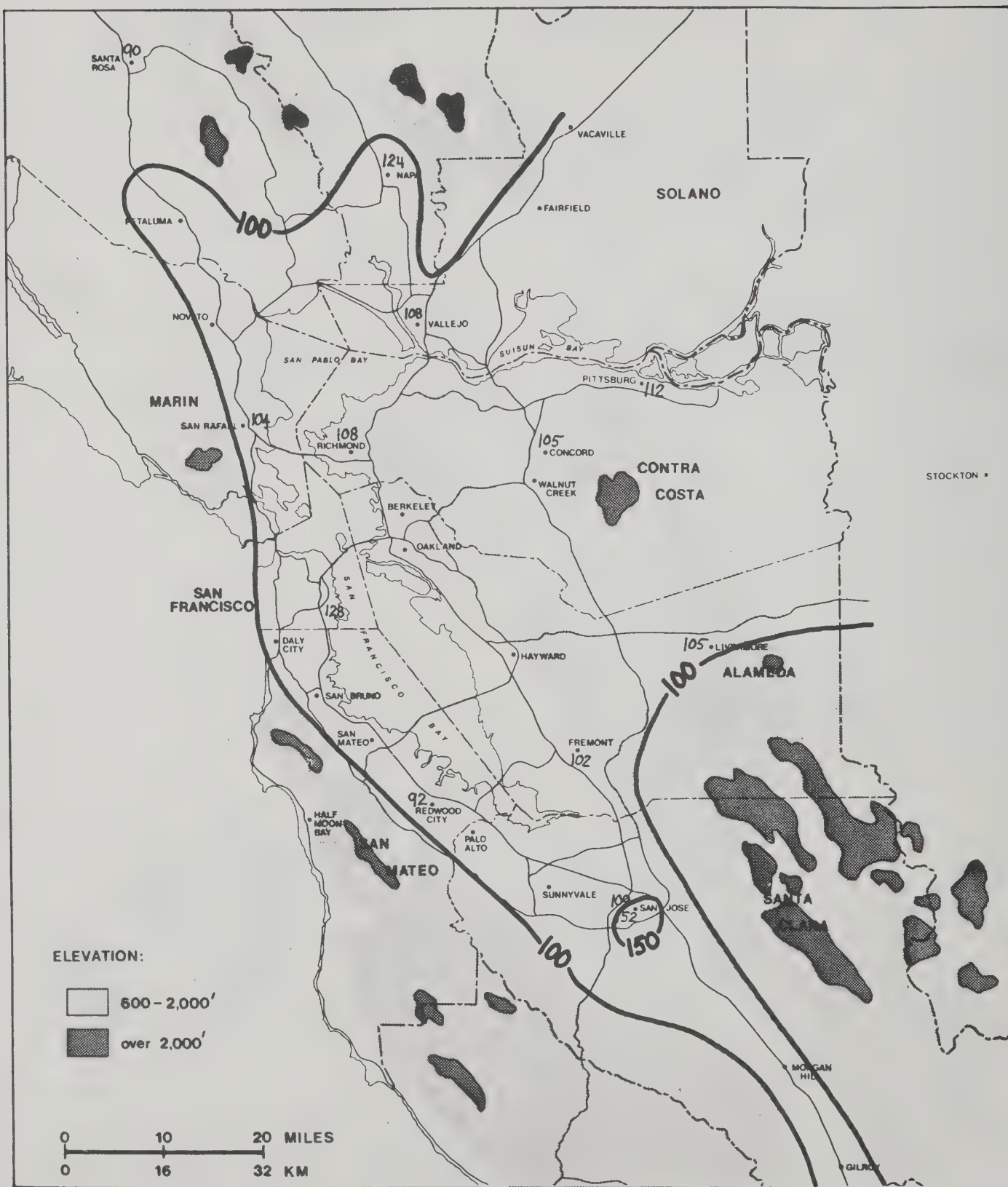


Figure V-B-9. Total Suspended Particulate (TSP)--24-Hour Background Values ($\mu\text{g}/\text{m}^3$)--1984



[illegible]

4. Trends in Air Quality Emissions

Figure V-B-11. Trends in Air Pollutant Emissions

The graphs show for each of the five main air contaminants the tons/day variation in emissions through the years. Solid portions of the curves represent historical emissions. These have been adjusted to be consistent with the 1982 Source Inventory and the latest computation techniques. Dotted portions of the curves indicate estimated emissions for the future.

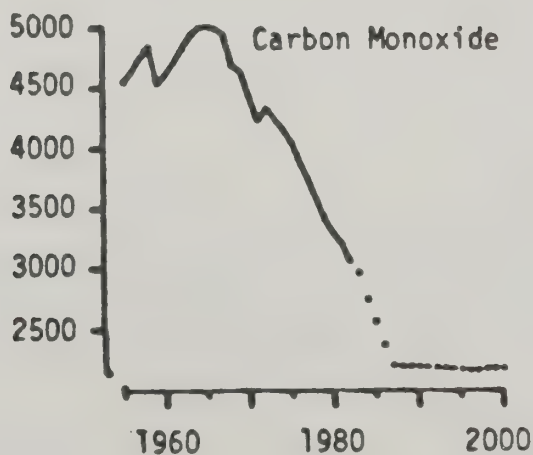
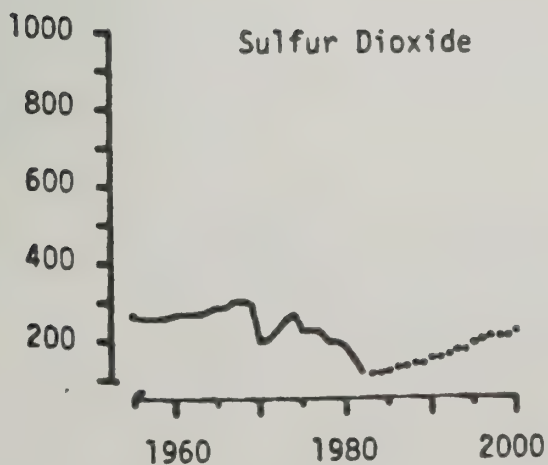
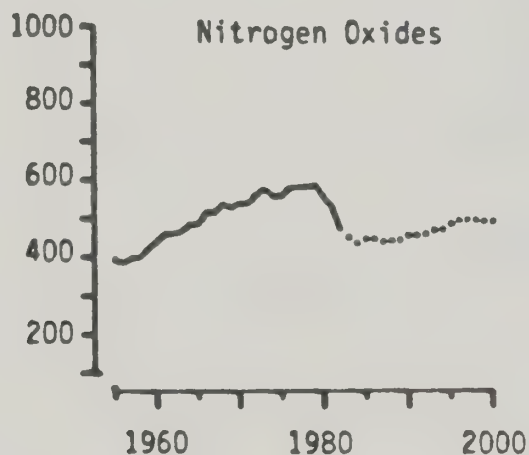
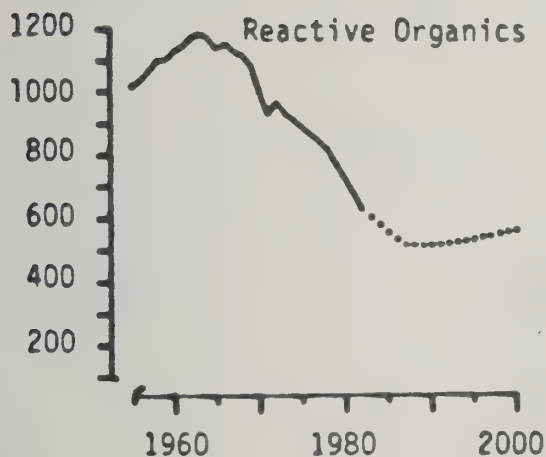
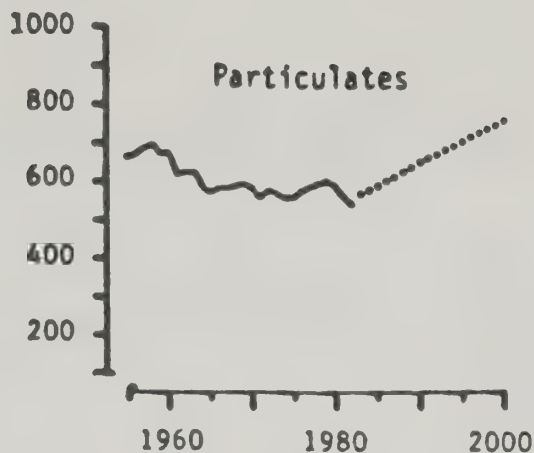


TABLE V-B-3. CARBON MONOXIDE - Number of Days on which the Federal 8-Hour Standard (9 ppm) was Exceeded.

Station	'75	'76	'77	'78	'79	'80	'81	'82	'83
San Francisco	3	4	0	1	2	0	1	1	0
San Rafael	1	7	0	1	1	0	0	0	0
Richmond	0	0	0	0	0	0	0	0	0
Pittsburg	0	0	0	0	0	0	0	0	0
Concord	0	0	0	0	1	0	0	0	0
Oakland	4	7	0	1	0	0	0	0	0
Fremont	0	1	0	0	0	0	0	0	0
Livermore	0	0	0	0	0	-	0	0	0
San Jose	18	61	32	23	17	15	5	9	2
Gilroy	0	0	0	0	0	0	0*	0*	-
Sunnyvale	9	14	1	-	-	-	-	-	-
Redwood City	2	10	0	2	0	0	0*	0*	1
Burlingame	0	1	0	0	0	-	-	-	-
Santa Rosa	1	1	0	0	2	0	0	0	0
Napa	0	2	1	0	0	0	0	0	0
Vallejo	12	40	13	1	1	3	0*	6*	1
Saratoga	-	-	-	0*	0	-	-	-	-

*Does not meet criteria for representativeness.

Table V-B-4. OZONE - Number of Days with Max-Hour Concentration Exceeding 12 pphm.

Station	Estimated Number of Exceedances*									Expected (Average) Annual Exceedances [†]						
	1975	1976	1977	1978	1979	1980	1981	1982	1983	75-77	76-78	77-79	78-80	79-81	80-82	81-83
Alum Rock	15.6	6.0	.0	17.4	4.3	8.5	4.0	3.1	5.1	7.2	7.8	7.2	10.1	5.6	5.2	4.1
Burlingame	.0	1.0	.0	2.3	.0	-	-	-	-	.3	1.1	.8	1.2	.0	-	-
Concord	1.0	8.3	2.1	11.1	.0	4.1	2.0	1.0	4.0	3.8	7.2	4.4	5.1	2.0	2.4	2.3
Fairfield	.0	3.1	1.2	1.0	.0	.0	.0	.0	.0	1.4	1.8	.7	.3	.0	.0	.0
Fremont	7.2	4.0	.0	10.0	2.1	6.1	3.0	3.1	7.1	3.7	4.7	4.0	6.1	3.7	4.1	4.4
Gilroy	5.0	9.0	.0	4.0	.0	10.3	1.0	.0	5.0	4.7	4.3	1.3	4.8	3.8	3.8	2.0
Hayward	9.9	7.4	.0	5.8	1.3	6.1	.0	.0	3.2	5.8	4.4	2.4	4.4	2.5	2.0	1.1
Kentfield	.0	.0	.0	-	-	-	-	-	-	.0	.0	.0	-	-	-	-
Livermore	8.0	8.0	3.0	2.1	3.0	2.0	2.3	1.0	8.2	6.3	4.4	2.7	2.4	2.4	1.8	3.8
Los Gatos	6.0	1.0	3.1	22.8	9.7	18.1	2.0	.0	12.1	3.4	9.0	11.9	16.9	9.9	6.7	4.7
Mountain View	4.0	1.0	1.0	1.0	1.0	.0	2.4	.0	5.1	2.0	1.0	1.0	.7	1.1	.8	2.5
Napa	3.0	.0	1.0	2.0	.0	.0	.0	.0	.0	1.3	1.0	1.0	.7	.0	.0	.0
Oakland	.0	3.0	.0	.0	.0	.0	.0	.0	.0	1.0	1.0	.0	.0	.0	.0	.0
Petaluma	.0	.0	.0	.0	.0	.0	-	-	-	.0	.0	.0	.0	.0	.0	-
Pittsburg	1.0	6.0	.0	6.0	1.0	1.0	.0	.0	2.1	2.3	4.0	2.3	2.7	.7	.3	.7
Redwood City	1.0	2.0	1.0	.0	1.0	2.0	1.0	.0	2.0	1.3	1.0	.7	1.0	1.3	1.0	1.0
Richmond	.0	1.0	.0	1.0	.0	.0	.0	.0	.0	.3	.7	.3	.3	.0	.0	.0
San Francisco	.0	1.0	.0	.0	.0	.0	.0	.0	1.0	.3	.3	.0	.0	.0	.0	.3
San Jose	8.0	7.0	3.0	12.2	4.0	3.0	1.0	.0	9.0	6.0	7.4	6.4	6.4	2.7	1.3	3.3
San Leandro	3.1	2.1	.0	2.1	1.4	6.2	.0	1.0	3.1	1.7	1.4	1.2	3.2	2.5	2.4	1.4
San Rafael	1.0	.0	.0	2.0	.0	.0	.0	.0	.0	.3	.7	.7	.7	.0	.0	.0
Santa Rosa	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Saratoga	-	-	-	7.3	2.4	-	-	-	-	-	7.3	4.9	4.9	2.4	-	-
Sonoma	5.1	1.0	.0	2.0	1.1	.0	.0	.0	.0	2.0	1.0	1.0	1.0	.4	.0	.0
Sunnyvale	4.1	4.0	1.0	-	-	-	-	-	-	3.0	2.5	1.0	-	-	-	-
Vallejo	3.1	5.0	1.0	2.0	.0	1.0	.0	.0	2.0	3.0	2.7	1.0	1.0	.3	.3	.7
Walnut Creek	5.1	3.3	1.1	5.8	1.2	.0	-	-	-	3.2	3.4	2.7	2.3	.6	.0	-

*Number of days with max hourly concentration more than 12 pphm, adjusted for instrument downtime.

[†]3-year averages of number of days with max-hour concentration more than 12 pphm.

TABLE V-B-5. TSP Trend and Supplementary Statistics. Annual geometric means (AGM) for Bay Area TSP monitors from 1976 to 1983. Numbers in the ">S" column are percent of days over the Federal 24-hour secondary TSP standard (150 g/m³). Numbers in the ">P" column are the percent of days over the Federal 24-hour primary TSP standard (260 g/m³).

Station	'76 >S >P	'77 >S >P	'78 >S >P	'79 >S >P	'80 >S >P	'81 >S >P	'82 >S >P	'83 >S >P
Berkeley	41 0 0	40 0 0	42 0 0	36 0 0	44 3 0			
Burlingame	41 0 0	35 0 0	41 2 0	35 0 0	53 0 0			
Concord	52 3 2	50 0 0	45 0 0	45 2 0	53 8 0	50 0 0	41 0 0	38 0 0
Fremont	61 6 0	60 0 0	60 2 0	55 2 0	61 7 0	56 0 0	46 0 0	43 0 0
Gilroy	62 0 0	63 0 0	57 0 0	54 0 0				
Livermore	85 11 0	68 2 0	64 2 0		64 2 0	53 0 0	42 0 0	43 0 0
Moorpark	69 2 0	59 0 0	60 0 0	59 2 0	77 0 0	55 2 0	45 0 0	38 0 0
Napa	61 2 0	53 0 0	52 0 0	51 0 0	58 4 0	53 0 0	50 0 0	46 0 0
Oakland	55 4 0	48 0 0	42 3 0	45 3 0	49 0 0			
Pittsburg	66 8 0	55 0 0	61 0 0	61 0 0	71 8 0	61 0 0	53 0 0	45 0 0
Redwood City	57 2 0	52 0 0	51 0 0	47 0 0	49 4 0	49 0 0	42 0 0	37 0 0
Richmond	58 2 0	51 0 0	52 0 0	51 0 0	57 2 0	58 0 0	50 0 0	45 0 0
SF-Ellis St	53 2 0	41 0 0	43 0 0	42 0 0				
SF-Potrero	63 10 0	56 0 0	48 0 0	52 6 0	56 2 0	66 0 0	57 0 0	55 0 0
San Jose	75 7 0	64 0 0	63 0 0	63 3 0	80 10 0	77 2 0	66 2 0	55 3 0
San Rafael	40 2 0	34 0 0	40 0 0	40 0 0	43 0 0	39 0 0	50 0 0	49 0 0
Santa Rosa	45 0 0	36 0 0	41 0 0	36 0 0	48 0 0	46 0 0	36 0 0	31 0 0
Saratoga			53 0 0	49 0 0	41 0 0			
Sunnyvale	50 2 0	45 0 0	55 0 0					
Vallejo	52 2 0	42 0 0	43 0 0	48 0 0	56 4 0	56 0 0	48 0 0	38 0 0

C. Bay Area Climate

1. Large-scale Influences

The summer climate of the West Coast is dominated by a semipermanent high centered over the north eastern Pacific Ocean. Because this high pressure cell is quite persistent, storms rarely affect the California coast during the summer. Thus the conditions that persist along the coast of California during summer are northwest flow and negligible precipitation.

A thermal low pressure area that extends northwestward into the Central Valley from the Sonoran-Mojave Desert is also a feature of the summertime west coast weather pattern. This causes air to flow onshore over the San Francisco Bay Area much of the time.

The steady northwesterly flow around the eastern edge of the Pacific Anticyclone exerts a stress on the ocean surface along the west coast. This results in some offshore motion of surface water, thereby inducing the upwelling of cold water from below. Upwelling is most pronounced along the coast of Northern California, producing a band of cold water that is approximately 80 miles wide off San Francisco. During July the surface waters off San Francisco are 3°F cooler than those off Vancouver, more than 700 miles farther north.

Air approaching the California coast, already cool and moisture-laden from its long trajectory over the Pacific, is further cooled as it flows across this cold bank of water near the coast, thus accentuating the temperature contrast across the coastline. This cooling is often sufficient to produce condensation and for this reason there is a high incidence of fog and stratus along the Northern California coast in summer.

In winter, the Pacific High weakens and shifts southward, upwelling ceases, and winter storms become frequent. Almost all of the Bay Area's annual precipitation is associated with the November through April period. During the winter rainy periods, inversions are weak or nonexistent, winds are often moderate and air pollution potential is very low. During winter periods when the Pacific High becomes dominant, inversions become strong and often are surface-based; winds are light and pollution potential is high. These periods are characterized by fog and winds that flow out of the Central Valley into the Bay Area.

2. Topography

The San Francisco Bay Area is characterized by complex terrain consisting of coastal mountain ranges, inland valleys and bays. Elevations of 1500 feet are common in the higher terrain of this area. It can readily be seen that normal wind flow over the area would be radically distorted in the lowest levels. This is particularly true when the airmass is stable and the wind velocity is not strong. With stronger winds and unstable airmasses moving over the area this distortion is reduced. The distortion is greatest when low level inversions are present with the surface air, beneath the inversion, flowing independently of the air above the inversion. This latter condition is very common in the summer, the surface airmass being the sea breeze.

3. Winds

In summer the northwest winds to the west of the Pacific coastline are drawn into the interior through the Golden Gate and over the lower portions of the San Francisco Peninsula. Immediately to the south of Mount Tamalpais, the northwesterly winds accelerate considerably and come more nearly from the west as they stream through the Golden Gate. This channeling of the flow through the Golden Gate produces a jet that sweeps eastward but widens downstream. Along its northern edge, air branches off toward the northeast producing southwest winds at Berkeley, while along its southern edge air curls off toward the southeast, producing northwest winds at San Jose. The northeastward-moving branch curves eastward through the Carquinez Strait and into the Central Valley. Wind speeds may be locally strong in regions where air is channeled through a narrow opening such as the Carquinez Strait, the Golden Gate, or San Bruno Gap. For example, the average wind speed at San Francisco International Airport at 3 p.m. to 4 p.m. in July is about 17 knots, compared with only about 7 knots at San Jose and less than 6 knots at the Farallon Islands. Figure V-C-1 shows the most common surface daytime flow patterns.

The sea breeze between the coast and the Central Valley commences near the surface along the coast in late morning or early afternoon and, as the afternoon progresses, the sea breeze layer deepens and intensifies while spreading inland. Initially, even the low regions of the northern end of the San Francisco Peninsula effectively block the flow so that it may be first observed only through the Golden Gate. As the breeze intensifies and deepens it flows over the lower hills farther south along the Peninsula. This process frequently can be observed as a bank of stratus "rolling over" the coastal hills on the west side of the Bay. Undoubtedly, the depth of the sea breeze depends in large part upon the height and strength of the inversion. The generally low elevation of this stable layer of air prevents marine air from flowing over the higher coastal hills. It is unusual for the summer sea breeze to flow over terrain exceeding 2000 feet in elevation.

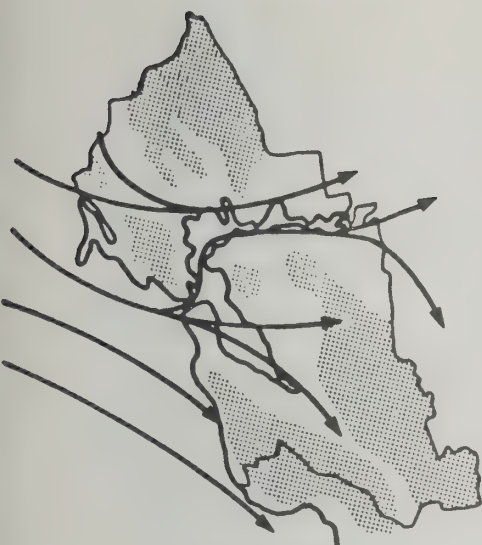
In winter, the Bay Area experiences periods of storminess and moderate-to-strong winds and periods of stagnation with very light winds. Winter stagnation episodes are characterized by outflow from the Central Valley, nighttime drainage flows in coastal valleys, weak onshore flows in the afternoon and otherwise light and variable winds.

4. Temperature

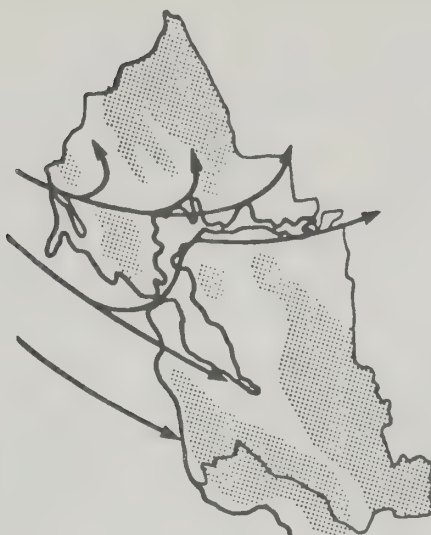
In summer, the distribution of temperature near the surface over the Bay Area is determined in large part by the effect of differential heating between land and water surfaces. This process produces a large-scale gradient between the coast and the Central Valley as well as small-scale local gradients along the shorelines of the ocean and bays (Figure V-C-2). The temperature contrast between coastal ocean water and land surfaces 15 to 20 miles inland reaches 35°F or more on many summer afternoons. At night this contrast usually decreases to less than 10°. Note how the overall temperature pattern is deformed around the bays, producing locally strong gradients.

Figure V-C-1.

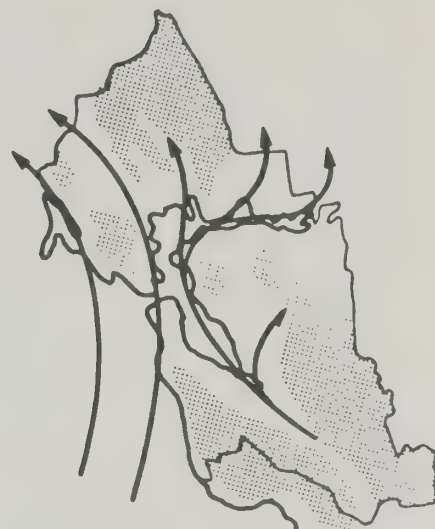
BAY AREA AIR FLOW PATTERN TYPES



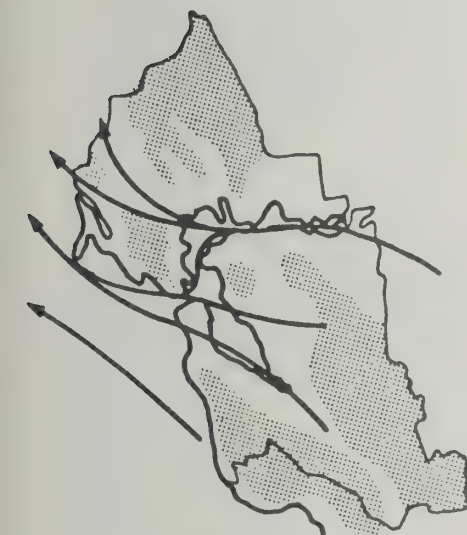
**Ia Northwesterly
(moderate to strong)**



**Ib Northwesterly
(weak)**



II Southerly



III Southeasterly



IV Northeasterly



V Bay Inflow



VI Bay Outflow

source: California Air
Resources Board
CALIFORNIA SURFACE
WIND CLIMATOLOGY
June 1984

The analysis of average maximum temperatures tells nothing of the day to day variations. For example, prevailing strong northwest flow sometimes occurs in late spring and early summer, associated with frontal troughs. Under these conditions, the marine inversion is either non-existent or high and weak and both large and small-scale horizontal temperature gradients are much smaller than usual in summer. On other occasions, especially during late summer and early autumn, the Pacific High may move inland creating a large-scale offshore pressure gradient sufficient to overcome the normal, thermally-induced, onshore pressure gradient. Then, with a very weak sea breeze, the temperature gradients are greatly increased over normal.

The winter mean temperature maxima and minima reverse the summer relationship in that daytime variations are small while mean minimum (nighttime) temperatures show large differences and strong gradients. Most apparent is the moderating effect of the ocean, with warmer minimums along the coast and penetrating the bay (Figure V-C-3). Coldest temperatures are in the sheltered valleys, implying strong radiation inversions and very limited vertical diffusion. An apparent anomaly of warmer temperatures in the Santa Clara Valley over San Jose is clearly an urban "heat island" effect, most pronounced on winter nights. Such heat islands are proportional to structure density, and could be expected to appear also over San Francisco and Oakland if the data array were dense enough to reveal them. From an example of one calm winter night, for example, the heat island effect over downtown San Francisco showed a magnitude of 20°F (Duckworth and Sandberg, 1954).

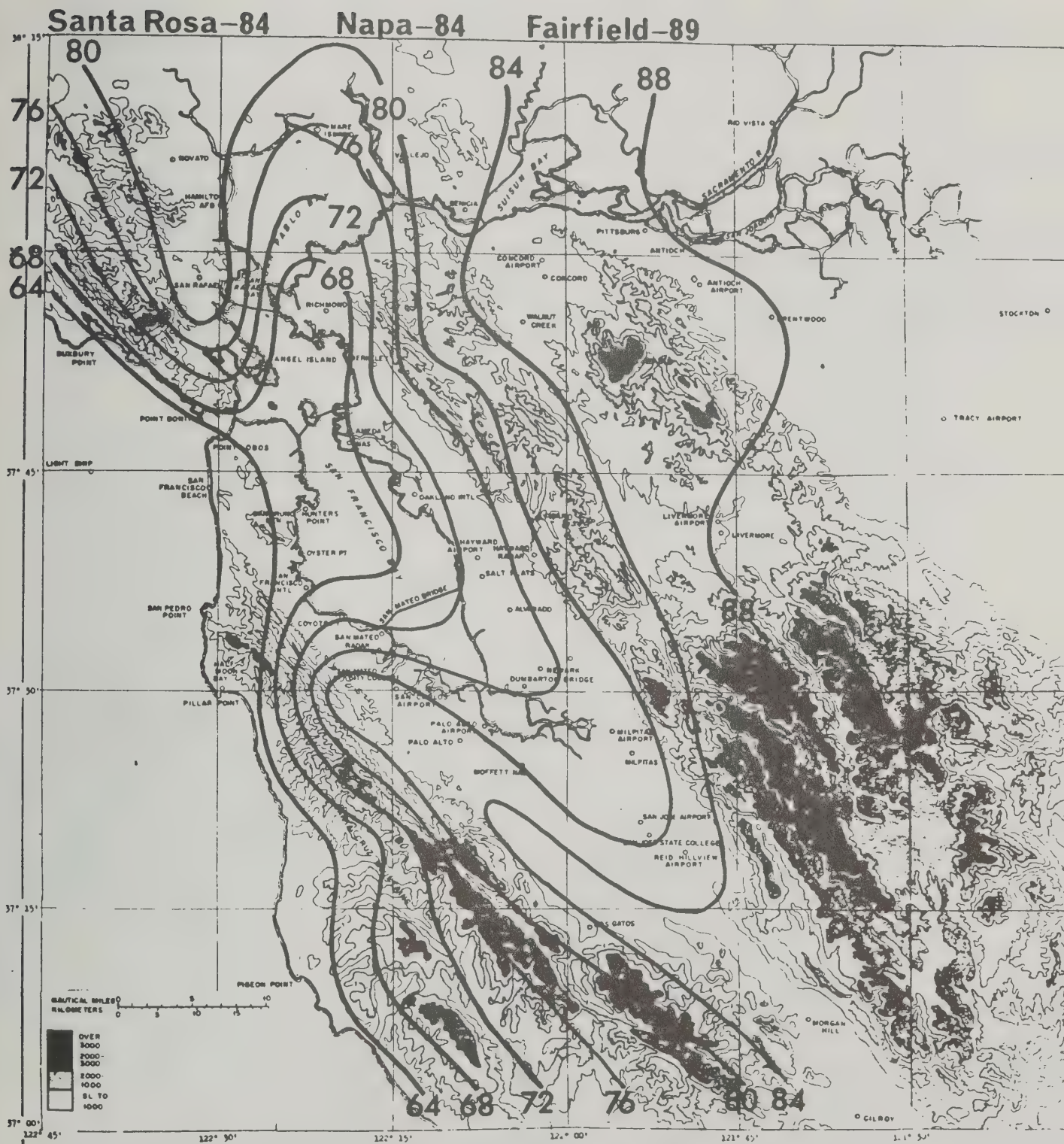
a) Inversions

A primary factor in air quality is the mixing depth, i.e., the vertical dimension available for dilution of contaminant sources near the ground. The frequent occurrence over the Bay Area of temperature inversions limits this mixing depth and consequently limits the availability of air for dilution. A temperature inversion may be described as a layer or layers of warmer air over cooler air.

Several types of temperature inversions are important. The strong inversions typical of summer are formed by subsidence, the adiabatic heating of downward-moving air in the high pressure anticyclone over the Western Pacific. The surface inversions typical of winter are formed by radiation as air is cooled in contact with the earth's cold surface at night. Both inversion mechanisms may operate at any time of the year. At times, surface inversions formed by radiational cooling may reinforce the subsidence inversion aloft, particularly in fall and winter. The thick, strong inversion resulting in this case is, of course, especially effective in trapping pollutants.

The only routine measurement of the vertical temperature structure over the Bay Area is that taken by the National Weather Service twice daily, at 4:00 am and 4:00 pm at Oakland International Airport.

Figure V-C-2. July Mean Maximum Temperature ($^{\circ}\text{F}$)



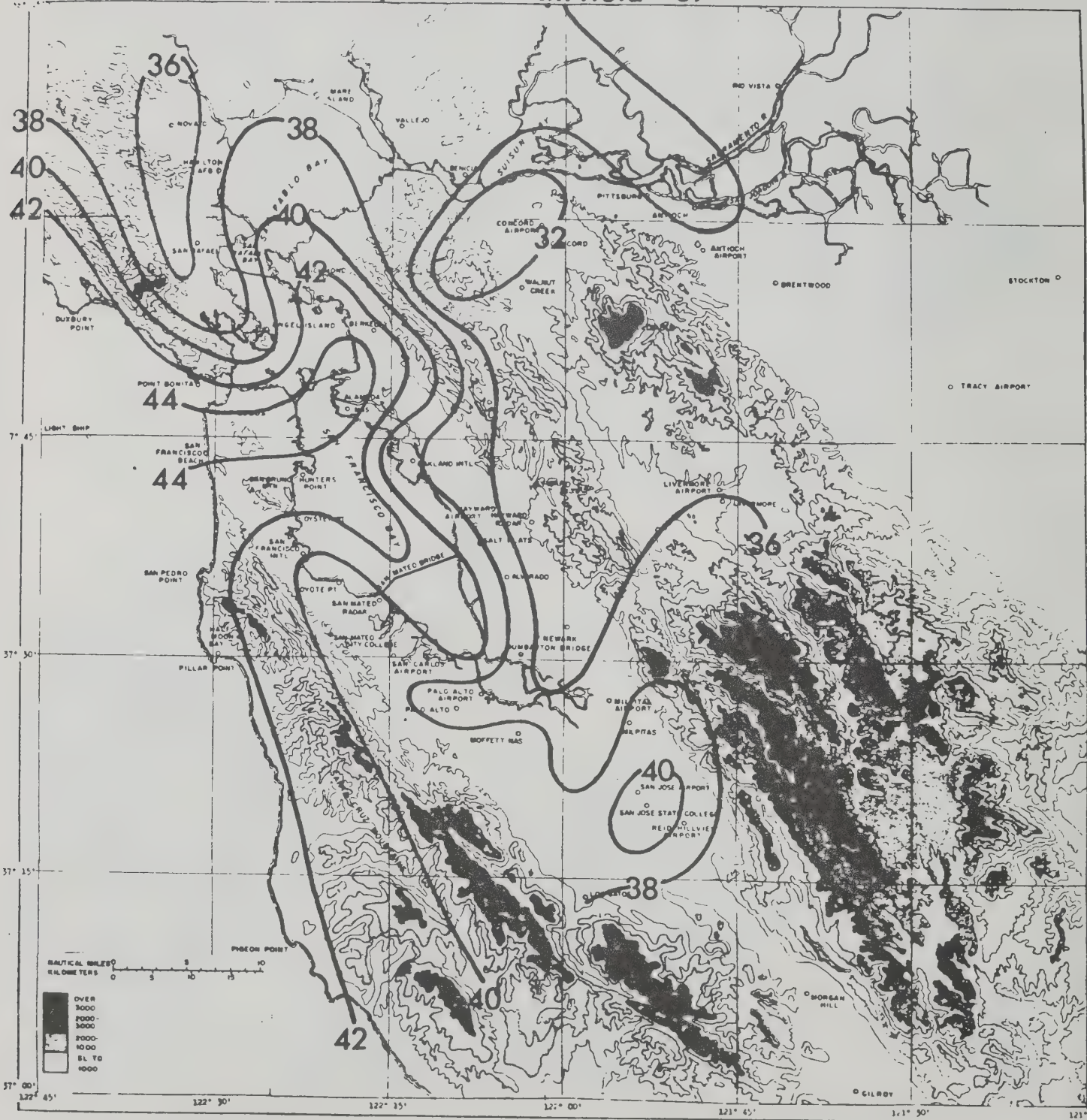
source: ABAG, Aviation Effect, 1971

Figure V-C-3. January Mean Minimum Temperatures ($^{\circ}\text{F}$)

Santa Rosa-36

Napa-36

Fairfield-37



source: ABAG, Aviation Effect..., 1971

There is wide seasonal variation in the type of inversion found, and there is wide variation over the course of the day in inversion characteristics. Moreover, the terrain of the Bay Area may induce significant variations from point to point. For example, Figure V-C-4 shows how the inversion base height is thought to have varied over the Bay Area on the afternoon of a September pollution episode.

To monitor the inversions and to calculate the daily ventilation index, the District since 1962 has made daily analyses of the Oakland radiosonde data. Six years of these data (1962-67) were examined and summarized to show the monthly and seasonal characteristics of the inversion base. For each day from 1 January 1962 through 31 December 1967, the 4:00 am and 4:00 pm Oakland soundings from the surface to 850 millibars (approximately 5000 feet) were categorized according to the base of the lowest temperature inversion (if any). Class intervals of 500 feet were used to determine the distribution of inversion bases by month.

The total cases of inversion base heights by 500-foot intervals are given in Table V-C-1 (for 4:00 am data) and in Table V-C-2 (for 4:00 pm data). These data are summarized by month for the six-year period (1962-67). The cases of no inversion below 5,000 feet are separated at the top of the tabulation by a dash bar; the cases of surface inversion are similarly set off at the bottom. Each table may be read across to show monthly (and seasonal) variation; it may also be read vertically to give inversion class frequencies for a given month. Comparison of the 4:00 am and 4:00 pm data provides some measure of diurnal variation.

In the morning data (Table V-C-1) the seasonal variations are most dramatic. From June through September there are only 8 days in 6 years with no inversion below 5,000 feet, less than 2 days per year. March and April, with 53 cases each, have the most frequent absence of morning inversions. The occurrence of surface inversions exceeds 100 cases from October through January, when the characteristic radiation inversion predominates. May through August have less than 30 such cases each. The wide cluster of cases between 500 and 2500 feet dominates from May through September, when the summer subsidence inversion over the marine layer dominates. The spread of cases among 500-foot classes indicates the day-to-day variability in the depth of the marine layer.

In the afternoon data (Table V-C-2), two differences from the morning data are most striking and significant. First is the frequent disappearance of the surface radiation inversion that dominates the winter months. In these months, a surface inversion observed in the morning persists through the afternoon less than 20% of the time. However, a corresponding afternoon increase may be noted in the cases from 500 to 2500 feet. Thus the inversion is frequently raised and perhaps weakened, but not destroyed. Second is the afternoon lowering of the marine inversion that dominates the summer months. In July and August the most frequent cases are in the 500 to 1000-foot interval, compared with the 1000 to 1500 foot interval in the morning.

(15 PST 29SEP78)



TABLE V-C-1. Distribution of inversion base heights by month for surface and 500-ft class intervals based on Oakland radiosonde 4:00 a.m. PST data for six years (1962-67).

Number of Inversion Occurrences												
Height	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
>5.0*	28	38	53	53	24	5	1	1	1	15	40	39
4.5-5.0	1	0	1	0	0	1	0	0	0	0	0	0
4.0-4.5	2	2	5	2	2	0	0	2	3	0	1	0
3.5-4.0	2	3	5	4	7	3	3	1	3	5	2	1
3.0-3.5	2	6	5	5	11	5	4	3	5	6	2	3
2.5-3.0	2	3	6	11	13	16	8	9	14	6	2	3
2.0-2.5	6	6	11	13	20	25	24	23	21	10	5	2
1.5-2.0	6	7	15	17	34	40	41	37	28	17	7	6
1.0-1.5	3	6	8	9	28	35	45	39	25	16	5	3
0.5-1.0	7	9	5	8	16	19	29	26	16	9	4	7
.001-.5	3	2	2	5	3	7	6	18	4	0	1	6
Surface	124	87	70	53	28	22	25	27	58	101	111	116

*Heights shown in thousands of feet. This row shows days with no inversion below 5000 feet

TABLE V-C-2. Distribution of inversion base heights by months for surface and 500-ft class intervals based on Oakland radiosonde 4:00 p.m. PST data for six years (1962-1967).

Number of Inversion Occurrences												
Height	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
>5.0*	56	66	93	92	42	17	03	02	23	40	88	58
4.5-5.0	2	8	11	2	3	1	1	0	1	7	3	2
4.0-4.5	7	12	5	8	3	1	1	0	1	7	3	2
3.5-4.0	9	8	18	3	4	3	0	1	1	7	11	8
3.0-3.5	14	9	11	3	9	6	1	1	7	15	10	8
2.5-3.0	12	10	4	4	9	3	1	4	6	8	9	7
2.0-2.5	15	9	7	10	12	13	5	8	13	7	9	11
1.5-2.0	18	13	7	10	19	26	19	13	14	12	11	17
1.0-1.5	10	9	8	14	25	33	34	29	26	25	16	20
0.5-1.0	10	9	5	15	37	44	70	68	46	19	5	18
.001-.5	10	8	6	19	20	29	47	53	34	35	4	16
Surface	23	8	7	5	3	1	5	7	8	16	7	15

*No inversion below 5000 feet

5. Precipitation

The San Francisco Bay Area climate is characterized by moderately wet winters and dry summers. Winter rains (December through March) account for about 75 percent of the average annual rainfall; about 90 percent of the annual total rainfall is received in the November-April period; and between 15 June and 22 September, normal rainfall is typically less than 1/10 inch.

Annual precipitation amounts (Figure V-C-5) show great differences in short distances. Annual totals exceed 40 inches in the mountains and are less than 15 inches in the sheltered or 'shadowed' valleys. The frequency of winter rain is more uniform, however, with 10 days per month (December through March) being typical.

During rainy periods, ventilation and vertical mixing are usually high, and consequently pollution levels are low. However, there are frequent winter dry periods lasting over a week. It is during some of these periods that CO and particulate pollution episodes develop.

6. Air Pollution Potential

The potential for the development of high pollutant concentrations in the surrounding area and at a given location depends upon the quantity of pollutants emitted in the surrounding area and the ability of the atmosphere to disperse them.

a. Atmospheric Pollution Potential

The combination of physiographic and climatological factors discussed above determine the condition referred to as the atmospheric pollution potential of the region. This potential might be defined quantitatively as the concentration developed in a region from a unit emission of pollutants; the term is usually used in a qualitative sense to describe the mixing power of the atmosphere. Here the atmospheric pollution potential is considered as independent of source configuration or development inside or outside the Bay Area and is a function only of physiographic and climatological features affecting atmospheric dilution. In the foregoing sense, the pollution potential is high in some Bay Area locations and low in other. Atmospheric pollution potential is in large part determined by the following four factors:

o Winds: The high frequency of low wind speeds due to the sheltering effect of surrounding terrain, and the reversal in wind direction with daytime up-valley and nighttime down-valley flow, contribute to the buildup of high concentrations of emitted pollutants. Low wind speeds limit the dilution resulting from transport away from source regions. Light winds occur most frequently during low sun (fall, winter and early morning) and no-sun (nighttime) periods. Since a commute traffic peak occurs in the early morning and late afternoon or evening and space heating is used primarily during the winter nighttime periods with highest frequency of low speed winds, the importance of the wind speed factor becomes apparent. The other wind factor in pollution potential is the directional reversal inherent in the thermal-topographic flow regime. During periods of atmospheric stagnation when the large scale (synoptic) wind flow over the Bay Area is weak, local thermal-topographic flow predominates. In the sheltered valleys of the Bay

Figure V-C-5. Precipitation--Pattern of mean annual precipitation in the San Francisco Bay Area (inches per year)



Area, such a situation results in flow toward the heated western slopes by day, and drainage back toward the lower elevations by night. If stagnation is prolonged, and polluted air passes back and forth across valley areas several times, the accumulation of pollutants is enhanced.

o Stability: The Bay Area experiences the stable atmospheric conditions common to all of coastal California. The inversion layer, which can act as a nearly impenetrable lid to the vertical mixing of pollutants, is typically based about 1500 feet above sea level (Tables V-C-1 and V-C-2) and is usually due to the compressional warming of air as it sinks toward the earth's surface under the influence of a vertical circulation established in the Pacific Coast high pressure cell. When local or seasonal cooling of the earth's surface occurs as it does most frequently in fall and winter months, ground based radiation inversions form. These are particularly conducive to concentrating pollutants, such as CO from auto exhaust, emitted close to the ground. The relatively low minimum temperatures in the inland valleys of the Bay Area attest to the high frequency of radiation inversions due to surface cooling.

o Solar radiation: The high frequency of clear (no cloud) sky conditions makes many inland areas especially prone to photochemical pollution. In the presence of sunlight and warm temperatures, hydrocarbons and oxides of nitrogen react to form secondary photochemical pollutants including ozone. Inland valleys of the Bay Area are prone to high summer temperatures and abundant sunshine; they are thus prone to the formation of photochemical pollutants if the proper chemical ingredients are provided. In late fall and winter sun angles are too low to allow significant ozone build-ups. However, clear skies permit the formation of the radiation inversions associated with winter air pollution episodes, usually carbon monoxide.

o Sheltering terrain: The mountains surrounding the valleys of the Bay Area are responsible directly or indirectly for much of the high pollution potential of some areas. The indirect effects have been discussed in terms of climatic features, but the hills also have a very direct effect. The horizontal dilution resulting from the meandering of wind flow currents is restricted, and concentrations are higher than they would be under flat terrain conditions. In addition, the sheltering terrain reduces the amount of exchange between the basin air and the broader scale synoptic flow, with the result that basin air is more prone than air in flat terrain to periods of stagnation.

In summary, then, the Bay Area is subject to a combination of physiographic and climatic factors which result in a low potential for pollutant buildups near the coast and a high potential in sheltered inland valleys. Because of the variety of meteorological factors bearing upon pollution potential, and the variety of combinations in which they can occur, it is difficult to describe pollution potential in quantitative terms. Qualitatively, however, the patterns of summer and winter pollution potential of the atmosphere probably resemble the patterns in summer-maximum and winter-minimum temperature (Figures V-C-2 and V-C-3), respectively.

In summer, areas with high average maximum temperatures tend to be sheltered inland valleys with abundant sunshine and light winds. Areas with low average maximum temperatures are exposed to the prevailing ocean breeze and experience frequent fog or stratus. Thus, locations with warm summer days have a higher pollution potential than the cooler locations along the coast and bays.

In winter, pollution potential is related to the nighttime minimum temperature. Low minimum temperatures are associated with strong radiation inversions in inland valleys that are protected from the moderating influences of the ocean and bays. Conversely, coastal locations experience higher average nighttime temperatures, weaker inversions, stronger breezes and consequently less air pollution potential.

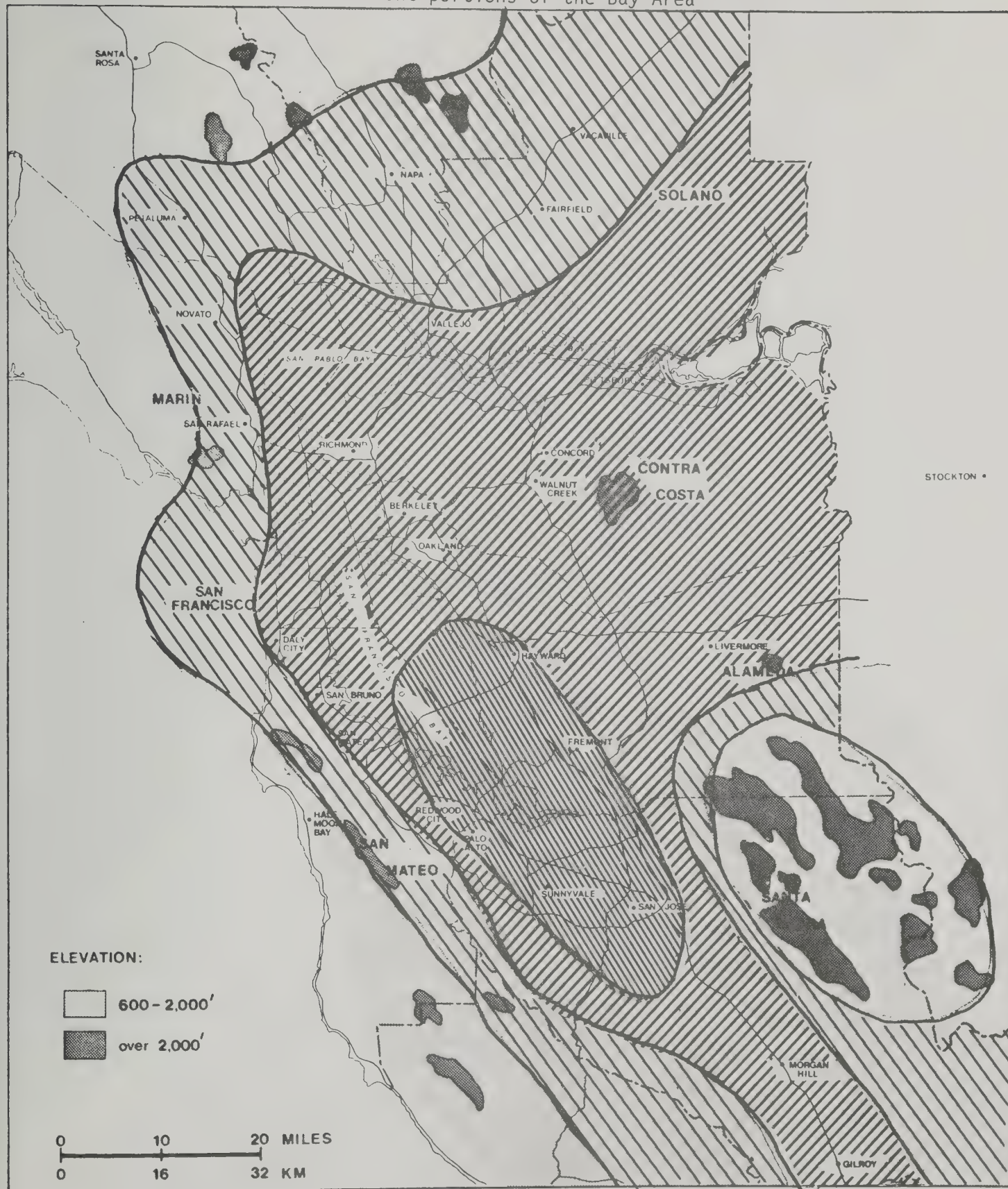
b. Pollution Potential Related to Emissions.

The air pollution potential of a given location depends upon the emission density in the surrounding area as well as the atmospheric potential. Primary pollutant emission densities are highest in areas with high population density, heavy vehicle use or industrialization. To illustrate, Figure V-C-6 shows a computer-generated contour map of vehicular CO emissions projected for 1985. Note that the highest emission density is in or near downtown San Francisco. Yet, because San Francisco has a low atmospheric pollution potential, it does not produce the highest ambient CO levels. The Bay Area's highest CO concentrations are found in San Jose, where both the atmospheric pollution potential and the emissions are high (see Figure V-B-4, for example).

For secondary pollutants like ozone, which develop over periods of several hours and which are derived from two or more primary pollutants, the evaluation of the pollution potential of a location is more complex. The emission-related ozone potential at a given location depends upon precursor emissions that are upwind of (rather than adjacent to) that location on an episode day. The most direct way of evaluating the potential for exceeding the ozone standard is to review ambient monitoring data for recent years. Violations of the ozone standard are most likely to occur in an arc around the west, south and eastern sides of the Santa Clara Valley (Ozone Map: Figure V-B-6).

In Figure V-C-7 we have attempted to show where incremental hydrocarbon emissions would be most likely to adversely affect ozone levels at Bay Area nonattainment sites. Emissions in the south bay/Santa Clara Valley area are shown to have the greatest impact because they will be likely to affect the areas that experience the highest ozone levels and most frequent exceedances of the standards.

Figure V-C-7. Ozone potential--An estimate of the relative impact of additional hydrocarbon emissions on ozone levels in nonattainment portions of the Bay Area



low
moderate
high
very high

hydrocarbons. A variety of non-criteria pollutants may also be emitted. Construction emissions consist mainly of suspended particulates from earth-disturbing activities and oxides of nitrogen from the engines of heavy equipment.

Methodology. The basic method for calculating emissions is to apply specific emission factors to sources whose magnitude and characteristics are either known or estimated. Emission factors may be defined as standardized relationships between particular source operations and their pollutant emissions. The more that is known about a source and its operating conditions, the more accurate the emission factor can be. For land use planning and CEQA purposes, emission factors are necessarily general and approximate in many cases.

For point sources being evaluated at an early planning stage, only a general planning or zoning classification may be available, e.g. "research and development" or "light industry", and assignment of emission factors may be difficult. The best "guestimate" of uses should be made. Where an industry designation like "electronic components" or "food processing" is known, or assumed, generalized emission factors may be used. We have provided such factors for a variety of industry types (Table VI-C-2).

The use of emission factors for mobile sources is often complex because the entire traffic network in the project vicinity must be considered, future traffic conditions must be estimated, and effects on non-project as well as project related mobile sources must be taken into account. For example, a project may add incremental traffic to an existing roadway or intersection causing additional congestion and thereby reducing speeds and increasing emissions from both existing and newly added vehicles.

Finally, the GUIDELINES user should remember that calculation of project emissions serves as the basis for evaluating the impact of the project on the local and regional air environment. This Chapter does not, however, deal with the impact of the surrounding vicinity on the project site and its residents. This latter kind of impact, discussed in Chapter IV, is of great importance and should not be ignored.

TABLE VI-A-1. EMISSION INVENTORY SUMMARY: 1982 Contaminant Levels*

(Tons/Day)

Use-Category	Alameda	Contra Costa	Marin	Napa	SF	San Mateo	Santa Clara	Solano	Sonoma	District Total
CO										
Residential	7	5	3	1	5	4	8	1	5	38
Commercial	0	0	0	0	1	0	0	0	0	1
Industrial	30	41	4	2	15	14	35	6	5	152
Infrastructure	0	4	0	0	1	0	0	0	0	5
Construction	2	1	0	0	2	1	2	0	0	9
Transportation	570	364	122	63	251	347	699	106	164	2686
Agricultural	2	2	0	11	0	1	6	2	2	26
TOTAL	611	417	129	78	274	367	750	115	177	2918
HC										
Residential	11	6	2	1	6	6	12	2	3	49
Commercial	5	4	1	1	3	3	6	1	1	25
Industrial	32	61	4	2	13	13	38	9	5	177
Infrastructure	2	8	0	0	3	1	3	1	0	18
Construction	6	4	1	1	4	3	7	1	1	28
Transportation	62	41	14	7	27	41	76	17	17	302
Agricultural	3	2	1	2	1	3	5	1	1	19
TOTAL	121	126	23	14	57	70	147	32	28	618
NO_x										
Residential	4	3	1	0	3	2	5	1	1	19
Commercial	1	0	0	0	1	0	1	0	0	5
Industrial	10	63	1	1	5	3	12	16	1	112
Infrastructure	0	52	0	0	24	0	0	0	0	77
Construction	2	2	0	1	2	1	2	0	1	10
Transportation	61	38	12	6	29	40	72	13	17	287
Agricultural	0	0	0	1	0	0	1	0	0	3
TOTAL	79	158	15	8	63	47	93	30	19	513
SO₂										
Residential	0	0	0	0	0	0	0	0	0	1
Commercial	0	0	0	0	0	0	0	0	0	1
Industrial	4	53	0	0	1	1	3	17	0	80
Infrastructure	-	16	0	0	2	0	0	0	0	17
Construction	0	0	0	0	0	0	0	0	0	1
Transportation	10	5	1	0	8	3	5	1	1	35
Agricultural	0	0	0	0	0	0	0	0	0	0
TOTAL	14	74	1	1	11	4	9	19	2	135
TSP										
Residential	0	0	0	0	0	0	1	0	1	3
Commercial	0	0	0	0	0	0	0	0	0	1
Industrial	9	12	1	0	4	2	4	1	1	33
Infrastructure	0	4	0	0	1	0	0	0	0	4
Construction	25	20	7	6	15	10	32	6	9	129
Transportation	53	33	11	8	24	32	64	8	12	244
Agricultural	14	15	5	1	8	25	22	16	3	108
TOTAL	100	83	24	16	51	69	122	31	26	523

*For detailed explanation of use-categories, see list on next page. HC tonnages exclude non-reactive hydrocarbons, such as methane and naturally occurring hydrocarbon emissions from vegetation. NO_x tonnages are as NO₂. Totals may differ slightly from sums of tabled values because of rounding.

INDEX TO EMISSION INVENTORY SUMMARY, BY SOURCE-USE-CATEGORY

More than 150 BAAQMD emissions inventory categories have been grouped into seven "source-use-categories." The new grouping attempts to resemble land use and planning operation classes, as utilized by local city and county planners.

The following listing details the type of sources grouped under each of the source-use-categories:

RESIDENTIAL: consumer products, space heating--residential, burning of waste material--residential;

COMMERCIAL (and INSTITUTIONAL): space heating--commercial and institutional, dry cleaners, burning of waste material--commercial and institutional, distribution and sale of gasoline;

INDUSTRIAL: various manufacturing categories, petroleum refining, production of food, industrial coating and metal cleaning, burning of waste material--industrial, "land-farming" (sewage-sludge incineration);

INFRASTRUCTURE (ENERGY): electric power generation, gas distribution;

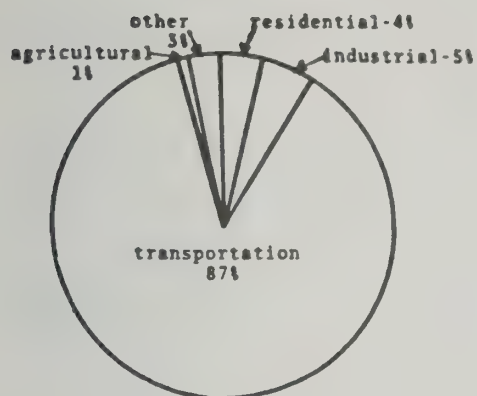
CONSTRUCTION (and BUILDING MAINTENANCE): painting of structures, paving of roads, accidental fires--structural;

TRANSPORTATION: motor vehicles, rail, shipping, aircraft, pleasure boats;

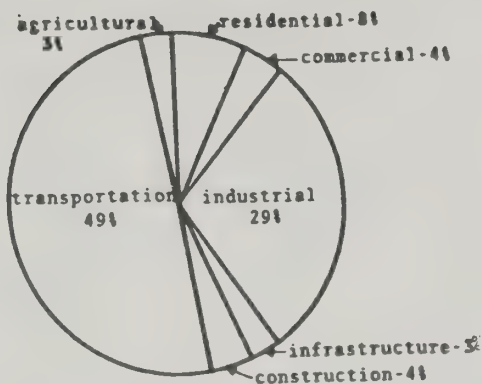
AGRICULTURAL (and NATURAL): farm tractors, farming operations, combustion of wastes--agricultural and other, accidental fires--vegetation and other.

An alternative method for estimating emissions from residential, commercial and industrial uses would attribute appropriate portions to each of infrastructure, construction and transportation emission categories. However, the data base at BAAQMD is not readily adaptable to such a method.

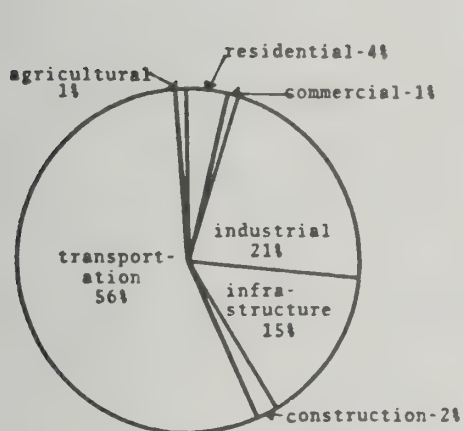
Figure VI-A-1. Sources of Contaminants-Annual Average-1982



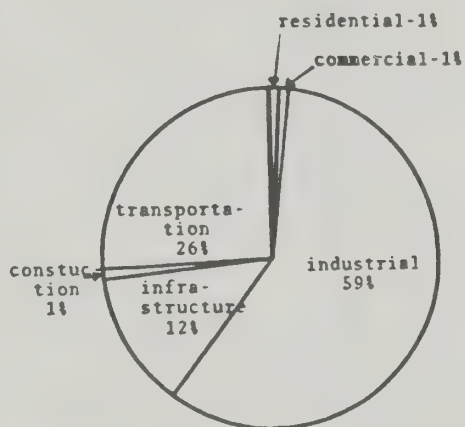
CARBON MONOXIDE



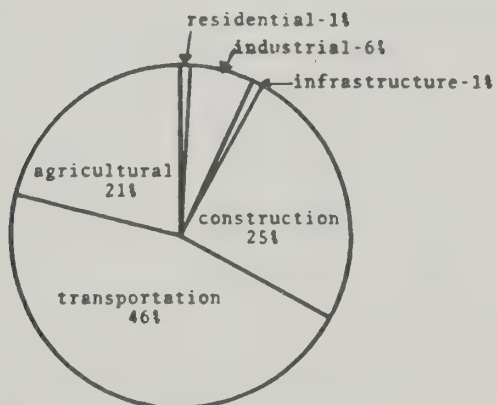
REACTIVE ORGANICS



NITROGEN OXIDES



SULFUR DIOXIDE



TOTAL SUSPENDED PARTICULATES

TABLE VI-A-2. PROJECTED EMISSIONS INVENTORY: Total and Motor Vehicle Generated in Bay Area Air Basin.

Annual Average in Tons/Day					
Year	CO	HC*	NOx	SO2	Part.**
1985					
Total	2550	546	448	122	590
Motor Vehicle (% of Total)	1943 (76%)	190 (35%)	216 (48%)	19 (16%)	271 (46%)
1990					
Total	2190	511	456	155	654
Motor Vehicle (% of Total)	1511 (69%)	143 (28%)	184 (40%)	23 (15%)	310 (47%)
1995					
Total	2160	532	486	195	708
Motor Vehicle (% of Total)	1450 (67%)	142 (27%)	183 (38%)	28 (14%)	351 (50%)
2000					
Total	2170	560	492	225	764
Motor Vehicle (% of Total)	1403 (65%)	193 (26%)	182 (37%)	34 (15%)	393 (51%)

*Reactive anthropogenic organics.

**Including dust entrained from roads.

Note: Projections based on 1982 BAAQMD emissions inventory.

B. PROJECTED EMISSIONS - MOBILE SOURCES

The traffic volumes and air pollutants generated by various developments in the Bay Area are of particular importance to the District and of equal importance to local planning agencies, municipal officials, as well as the general public.

There is a growing concern centered around the development of those land-uses having high rates of trip generation. The question that often arises is "How much traffic will be produced from a given development"? This is important because access facilities and roadways are needed for the traffic generated, and because those officials having the responsibility of granting or denying use permits need information on traffic conditions and resulting air quality impacts.

In order to prepare the air quality impact report, a comprehensive traffic analysis is required as a basis for developing detailed data on vehicular emissions generated by the project. The traffic analysis should be performed by a competent traffic engineer or transportation planner, and should be appropriate to the nature and scale of the project. Generally, traffic impact analysis involves four major phases: trip generation analysis, trip distribution and assignment procedure, roadway and site access requirements analysis, and evaluation. The evaluation phase includes the existing and future capacity analyses on the roadways and development of improvement plans if they are required. The minimum information and data required for traffic analysis are described in the following sections.

Trip Generation. Trip generation analysis is the most important phase in the travel forecasting procedure. Its purpose is to identify and quantify the total trips generated from the land use activity, and to determine the maximum impact on the adjacent street and highway system. This will include a study of the number of vehicles entering and leaving, particularly during the p.m. peak hour.

Average trip rates are based on size and activity variables such as: developed land area, development density, employment, floor area, number of patient beds, etc., for the various kinds of land use. Table VI-B-1 presents recommended trip generation rates for various land uses. These should be used as default values in the absence of other reliable data specific to the project or local area. Table VI-B-1 also contains average peaking factors for one and eight-hour periods which would be inputs for modeling. This information was compiled from the analyses on the various trip generation studies in the Bay Area and other metropolitan areas. However, a specific generation rate for a selected project should be based on the unique characteristics of the area, if these can be calculated, i.e., transit service coverage, land use mix, vehicle occupancy rate, mode choice, and socio-economic characteristics. Since trip generation and trip length factors are averages for the Bay Area, there is likely to be substantial variation in actual rates, e.g. between central cities and outlying suburban areas.

If possible, the peak hour factor should be checked with actual road counts for accuracy. In determining worst case level of service, nearby freeway and street peak hour volume may be more important than the peak volume at a specific development site. The peak hour should be identified. If only daily traffic is known, the convention is that peak hour equals 10% of daily.

Trip Distribution and Assignment Procedure. The spatial or geographical distribution of total trips generated by a selected land use is important not only to the location, design and operation of the development, but also to the design and operation of the adjacent roadway networks. The distribution of market areas strongly influences the major directional movements of traffic to and from the development.

Total vehicular trips generated by different land uses have to be distributed to the local road network. Information on trip purpose and trip length frequency distribution will be useful in this process. The logic of assigning the major directional movements of the generated traffic to each street should be clearly defined.

Roadway Analysis. In order for a development of specific size to function efficiently, the internal and external traffic systems must be coordinated. A calculation and analysis of existing and projected traffic conditions should be made, with a project map specifying: average daily, maximum 8-hour, peak hour and 6-9 a.m traffic; estimates of vehicle speeds for the time period specified above; roadway capacity; lane, median, and shoulder width; traffic control devices; and level of service.

Evaluation. In order to adequately accommodate traffic both now and in the future, capacity analyses on adjacent intersections and roadways are necessary to indicate where and when roadway improvements are required for the proposed development, and to determine at what level of service the crucial intersections and roadways will be operating. In other words, the purpose of the capacity analysis is to investigate the traffic impact (in terms of traffic congestion) of the proposed development, not only on the roadways immediately adjacent to the site, but on the impacted area roadway networks as well. Frequently, qualitative measurement of the roadways is considered in terms of "Level of Service" (LOS), a term adopted by the Highway Research Board in 1965 to describe the quality of traffic flow. (LOS A--free flowing--through LOS F--stop and go, very congested.) They are referred to frequently in the evaluation phase of the traffic studies. Among the parameters included in these measures are speed, travel time, traffic interruptions, freedom to maneuver and driving comfort.

Model Split and Transportation System Management. Any analysis of roadway problems and needs should take into account potential diversion of motor vehicle trips due to future utilization of transit and/or effectiveness of Transportation System Management (TSM) measures to reduce use of the single-occupancy automobile (see Chapter IX). For instance a transit service analysis would disclose what service is available, how much capacity could be added, and what ridership could be expected in future years. A bicycle system analysis would disclose what kind of trips are being made and how improvements to the network and facilities might induce increased usage.

Motor Vehicle Emissions Tables and Calculations. The following tables contain motor vehicle emission rates for criteria pollutants of concern in the Bay Area (which rates have been modified to reflect the expected benefits of the Inspection and Maintenance program) and factors to be used in estimating total emissions from many common types of development projects, e.g. trip generation rates, average trip lengths, cold start/hot start correction factors. The simple formula for calculating total emissions from a

project is presented in Chapter VII, page VII-8.

Cold Start/Hot Start Correction Factors. Emission rates in Table VI-B-2 are based on a standardized mix of cold start, hot start and hot stabilized emissions, as derived from observation of motor vehicles on the road, irrespective of the type of trip being made. In actuality some types of trips are more likely to be of the cold start variety, e.g. the journey to work trip. Trips to industrial sites are 90% this type. In the morning the vehicle to be used is almost always cold. In the evening the automobile is usually cold again, not having been used for eight or so hours. On the other hand trips to a shopping center may begin with a hot or cold start. The trip home is almost always a hot start.

Since the emission levels may vary significantly between cold and hot starts, and because short trips in a cold started vehicle produce proportionately more emissions (see Figure VI-B-1), a table of correction factors has been worked out (Table VI-B-3). This is based on the California Air Resources Board's URBEMIS model. Using this table allows the analyst to compensate for the standardized emission rates in any calculations performed, depending on what type of land use is being proposed.

TABLE VI-B-1. RECOMMENDED TRIP GENERATION CHARACTERISTICS TO BE USED FOR ANALYSIS

Selected Land Use	Recommended Trip Generation Unit	Recommended Trip Generation Rate	Recommended Peaking Factor (% of ADT)		Normal Peak Hour	Normal 8-Hour Accumulation	Recommended Trip Length
			1-hr	8-hr			
A. Highways and Roads							
Highway & Freeway			8.5	55	5 pm - 6 pm	12 pm - 8 pm	
Local Street			10	60	5 pm - 6 pm	12 pm - 8 pm	
B. Residential							
Single-Family	dwelling unit	10.0/d.u.	10	60	5 pm - 6 pm	1 pm - 9 pm	6.2
Apartment	dwelling unit	5.7/d.u.	12	50	5 pm - 6 pm	12 pm - 8 pm	6.2
Mobile Home	dwelling unit	5.4/d.u.	12	50	5 pm - 6 pm	12 pm - 8 pm	6.2
Retirement Home (Retirement Community)	dwelling unit	3.3/d.u.	10	60	3 pm - 4 pm	3 pm - 4 pm	3.0
C. Parking Garage*							
Long-term Facility	parking space	1.4/space	60	70	7 am - 8 am	7 am - 3 pm	5.0
Short-Term Facility	parking space	6.0/space	20	60	12 pm - 1 pm	12 pm - 8 pm	3.7
D. Shopping Center and Other Retail							
Regional Shopping Center	gross floor area	40/1,000 sq.ft.	10	70	12 pm - 1 pm	12 pm - 8 pm	5.0
Convenience Shopping (Including individual Retail Store	gross floor area	48/1,000 sq.ft.	10	70	12 pm - 1 pm	12 pm - 8 pm	3.7
Neighborhood Shopping Center	gross floor area	86/1,000 sq.ft.	14	80	5 pm - 6 pm	12 pm - 8 pm	2.0
E. Industrial							
Industrial Park	acreage	64/acre	15	60	4 pm - 5 pm	10 pm - 6 pm	9.6
Warehouse	acreage	81/acre	20	60	7 am - 8 am	7 am - 3 am	9.9
Mass Production	acreage	93/acre	25	70	7 am - 8 am	7 am - 3 pm	9.6
Administration	gross floor area	10/1,000 sq.ft.	25	65	4 pm - 5 pm	10 am - 5 pm	9.6
Research and Development	gross floor area	10/1,000 sq.ft.	25	65	4 pm - 5 pm	10 am - 5 pm	9.6
F. Office Building							
Government Office Building	gross floor area	65/1,000 sq.ft.	35	70	4 pm - 5 pm	10 am - 6 pm	6.2
Commercial Office Building	gross floor area	15/1,000 sq.ft.	25	60	5 pm - 6 pm	10 am - 6 pm	6.2

*Do not double-count parking if garage provides required parking for a residential, commercial or other land-use.

TABLE VI-B-1. (Continued)

Selected Land Use	Recommended Trip Generation Unit	Recommended Trip Generation Rate	Recommended Peaking Factor (% of ADT)		Normal Peak Hour	Normal Highest 8-Hour Accumulation	Recommended Trip Length
			1-hr	8-hr			
<u>G. Hotel and Motel</u>							
Hotel	room	2.5/room	15	50	5 pm - 6 pm	11 am - 7 pm	7.0
Motel	unit	10.0/unit	9	55	12 pm - 1 pm	11 am - 7 pm	5.4
<u>H. Restaurant</u>							
Restaurant	seat	3.0/seat	20	70	6 pm - 7 pm	12 pm - 8 pm	5.3
Fast Food	employment	75.0/employee	17	70	12 pm - 1 pm	12 pm - 8 pm	3.7
<u>I. Theater</u>							
Theater	seat	2.5/seat	35	90	6 pm - 7 pm	6 pm - 2 pm	2.5
<u>J. Educational Institute</u>							
University	student	2.5/student	10	60	5 pm - 6 pm	10 am - 6 pm	7.0
College	student	2.0/student	10	60	5 pm - 6 pm	10 am - 6 pm	5.0
Public School	student	1.31/student	25	80	7 am - 8 pm	7 am - 3 pm	3.0
<u>K. Hospital</u>							
Hospital	bed	10.0/bed	12	55	4 pm - 5 pm	12 pm - 8 pm	3.0
<u>L. Recreational Facility</u>							
Marina	berth	5.0/berth	15	60	12 pm - 1 pm	11 am - 7 pm	5.0
Race Track	attendance	1/2.5 attendance	27	95	5 pm - 6 pm	10 am - 6 pm	15.0
Amusement Park	attendance	1/4.2 attendance	30	80	12 pm - 1 pm	10 am - 6 pm	15.0
<u>M. Sport Stadium</u>							
Sport Stadium	seat	1/3 seat	75	80	after the game	varies depend on game time	20.0
<u>N. Airport</u>							
International Airport	daily flight	varies by airport	7	60	11 am - 12 pm	8 am - 4 pm	20.0
Municipal Airport	daily flight	5/daily flight	11	70	4 pm - 5 pm	10 am - 6 pm	5.0

Sources:

1. California Department of Transportation, "Progress Report on Trip Generation Research Counts," Vols. 1-14 (1965-1982).
2. California Statewide Transportation Study, TRW (Redondo Beach, California), 1966.
3. California Department of Transportation, "The 1976-1980 Statewide Travel Survey," 1981.
4. National Corporative Highway Research Program, "Urban Travel Pattern," 1966.
5. Western Section Institute of Traffic Engineers, "Trip Generation," 1967.
6. Various trip generation studies conducted in the Bay Area and other Metropolitan areas.

TABLE VI-B-2. COMPOSITE EMISSION FACTORS BY POLLUTANT AND SPEED

(gram/mile)

Average Speed (miles per hour)

Pollutant	5	10	15	20	25	30	35	40	45	50	55	60
- 1985 -												
Carbon Monoxide	72.26	39.76	28.37	21.03	18.86	15.95	13.81	12.46	11.81	11.62	11.21	9.72
Hydrocarbons	6.71	3.96	2.97	2.49	2.17	1.90	1.71	1.59	1.52	1.47	1.45	1.30
Nitrogen Oxides	2.26	2.00	1.93	1.97	2.05	2.14	2.23	2.32	2.43	2.60	2.90	3.41
Sulfur Oxides	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21
Particulates*	.34	.34	.34	.34	.34	.34	.34	.34	.34	.34	.34	.34
- 1990 -												
Carbon Monoxide	49.32	27.20	19.54	15.71	13.11	11.21	9.60	8.66	8.22	8.10	7.73	6.40
Hydrocarbons	4.63	2.67	2.00	1.64	1.39	1.21	1.07	.98	.93	.91	.86	.75
Nitrogen Oxides	1.70	1.49	1.42	1.44	1.50	1.57	1.64	1.71	1.80	1.94	2.18	2.60
Sulfur Oxides	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21
Particulates*	.31	.31	.31	.31	.31	.31	.31	.31	.31	.31	.31	.31
- 1995 -												
Carbon Monoxide	42.11	23.15	16.67	13.47	11.27	9.54	8.26	7.44	7.06	6.93	6.60	5.42
Hydrocarbons	4.00	2.36	1.74	1.32	1.20	1.03	.91	.82	.75	.78	.72	.63
Nitrogen Oxides	1.52	1.33	1.27	1.29	1.34	1.41	1.47	1.54	1.62	1.75	1.98	2.37
Sulfur Oxides	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21
Particulates*	.31	.31	.31	.31	.31	.31	.31	.31	.31	.31	.31	.31
- 2000 -												
Carbon Monoxide	39.70	21.72	15.66	12.68	10.64	9.01	7.79	7.02	6.66	6.54	6.21	5.05
Hydrocarbons	3.99	2.28	1.67	1.25	1.14	.98	.87	.78	.74	.71	.66	.58
Nitrogen Oxides	1.45	1.27	1.21	1.23	1.29	1.35	1.41	1.48	1.56	1.68	1.90	2.28
Sulfur Oxides	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21
Particulates*	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30

*Particulate emission factors represent only exhaust and tire wear. Add 2.0 gm/mi for dust entrainment from paved roadways (EPA Publication AP-42, Supplement No. 9, 11.2.5-3, 12/77).

- Source:
- 1) EMFAC6D developed by California Air Resources Board (5/85).
 - 2) Vehicle mix for a given year is based on the San Francisco Bay Area vehicle mix.
 - 3) The above emission factors are calculated under the following set of conditions.
 Ambient Temperature: 75 degrees Fahrenheit for HC, NO_x, SO₂, and Part;
 50 degrees Fahrenheit for CO.
 Cold Start: 21 % of mileage (first 505 seconds or 3.6 miles)
 Hot Start: 27 % of mileage
 Hot Stabilized: 52 % of mileage
 - 4) Hydrocarbon emission factors include crankcase blowby, diurnal, and hot soak emissions.
 - 5) I/M effectiveness on light-duty vehicles for 1985, 1990, 1995 and 2000 are included.

TABLE VI-B-2.1. COMPOSITE IDLE EMISSION RATES FOR LIGHT DUTY VEHICLES*

Year	(grams/minute)		
	Pollutant		
	CO	HC	NO _x
1985	2.75	.26	.07
1990	2.07	.20	.05
1995	1.82	.18	.04
2000	1.76	.17	.04

*Composite idle emission rates are based on CARB's EMFAC6D.

**Composite idle emission rates for interval years can be obtained by interpolation.

Revised 7/85

TABLE VI-B-3. COLD START/HOT START CORRECTION FACTORS.

Selected Land Use	1 9 8 5			1 9 9 0			1 9 9 5			2 0 0 0		
	HC	CO	NO _x	HC	CO	NO _x	HC	CO	NO _x	HC	CO	NO _x
A. <u>Highways and Roads</u>	--	--	--	--	--	--	--	--	--	--	--	--
B. <u>Residential</u>												
Single Family, Apartment	1.07	1.05	.79	1.03	1.12	.74	1.08	1.15	.73	1.08	1.21	.73
Mobile Homes												
C. <u>Parking Garage</u>	--	--	--	--	--	--	--	--	--	--	--	--
D. <u>Shopping Center</u>												
All types of Shopping Centers	1.04	1.03	.82	1.27	1.07	.74	1.31	1.10	.76	1.18	1.01	.76
E. <u>Industrial</u>												
Industrial Park	.93	.86	.77	.93	.90	.70	.95	.92	.73	.96	.94	.72
Warehouse	.92	.80	.77	.92	.83	.69	.94	.91	.73	.95	.85	.73
Mass Production	.99	1.07	.78	0	1.14	.72	1.02	1.17	.79	1.04	1.20	.75
Administration	.92	.83	.77	.92	.86	.69	.94	.88	.73	.95	.89	.74
Research & Development	.87	.90	.77	.94	.94	.70	.96	.96	.73	.97	.98	.74
F. <u>Office Building</u>												
Government Office Bldg.	1.13	1.00	.80	1.14	1.04	.72	1.18	1.07	.75	1.20	1.09	.76
Commercial Office Bldg.	1.17	1.13	.74	1.18	1.19	.73	1.22	1.20	.73	1.25	1.26	.77
G. <u>Hotel and Motel</u>												
Hotel	1.05	.90	.80	1.06	.95	.71	1.09	.97	.74	1.11	.99	.75
Motel	1.20	1.00	.75	1.21	1.02	.73	1.25	1.04	.76	1.27	1.07	.76
H. <u>Restaurant</u>												
Restaurant	1.21	1.00	.81	1.22	1.01	.74	1.16	1.06	.73	1.14	1.09	.76
Fast Food	1.42	.93	.81	1.44	.93	.74	1.49	.95	.77	1.52	.97	.77
I. <u>University</u>												
University College	1.09	.85	.79	1.05	.90	.71	1.07	.92	.76	1.09	.93	.74
Public School	1.74	1.32	.89	1.78	1.44	.80	1.86	1.49	.82	1.90	1.54	.83
J. <u>Theater</u>	1.55	1.50	.93	2.04	1.64	.83	2.13	1.70	.86	2.27	1.76	.86
K. <u>Hospital</u>	1.83	1.65	.92	1.88	1.80	.83	1.97	1.88	.86	2.01	1.94	.86
L. <u>Recreational Facility</u>												
Marina	1.24	1.02	.82	1.27	1.07	.74	1.32	1.10	.76	1.34	1.03	.77
Race Track & Amusement Park	--	--	--	--	--	--	--	--	--	--	--	--
M. <u>Sport Stadium</u>	--	--	--	--	--	--	--	--	--	--	--	--
N. <u>Airport</u>												
International Airport	--	--	--	--	--	--	--	--	--	--	--	--
Municipal Airport	1.27	1.06	.90	1.28	1.13	.74	1.33	1.16	.77	1.35	1.19	.77

HYDROCARBON EMISSIONS - 7 MILE TRIP

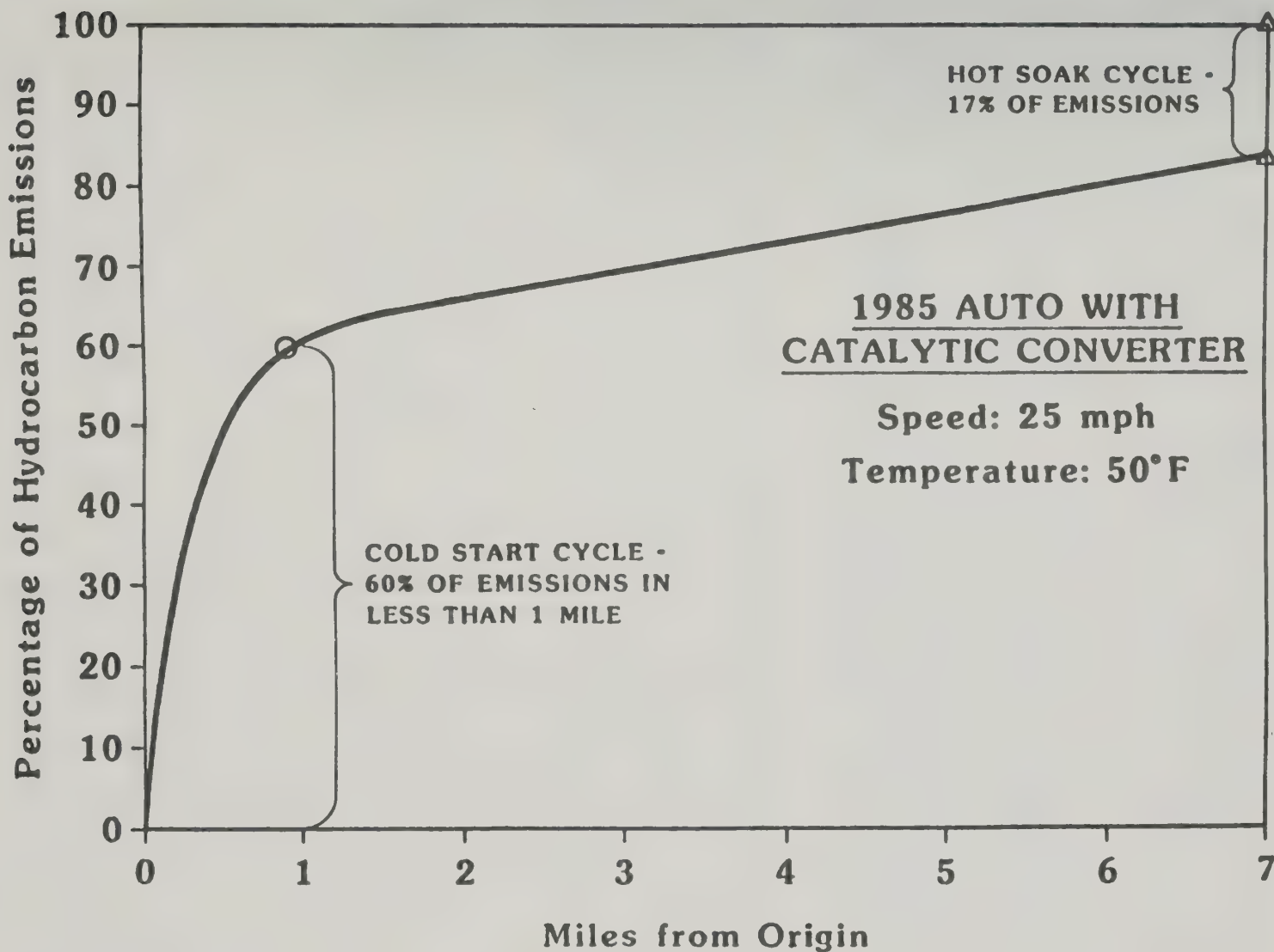


Figure VI-B-1. Hydrocarbon Emissions - 7 Mile Trip

Source: California Air Resources Board

C. Stationary Sources

Table VI-C-2 contains very generalized estimates of contaminant emissions for a number of categories of industrial and related land uses found in the San Francisco Bay Area. The estimated units are in terms of pounds of contaminant per acre per day. They were derived from information in the BAAQMD's inventory files. Caution should be exercised in using these figures because of the wide diversity of facility types under each of the categories. However, they may be valuable as first estimates of contaminant levels to be expected when only the general category of development is known--before there is more specific information about facility design, size, number of employees, etc. When specific activities are known, E.P.A. publication AP-42, and its amendments, should be used for estimating stationary sources emissions.

The estimates do not include the emissions that can be expected from motor vehicles attracted to these uses. These indirect source emissions should be calculated separately, as explained earlier in the Mobile Source Emissions Section. Total emissions generated by any use would, of course, be the sum of the direct and the indirect emissions calculated.

Residential and Related Uses as Stationary Sources. In terms of degradation of air quality, residential and residence-serving uses generate contaminant emissions much more from mobile sources (motor vehicles) than as stationary sources. However there are certain stationary source emissions which are attributable to residences--e.g.: from domestic home heating; fireplace use, architectural coating (house paints); lawnmowers and other domestic fuel burning engines; accidental domestic fires, use of aerosols and other volatile consumer products. A rough estimate of the total emissions from the above domestic uses is:

TABLE VI-C-1. Residential Stationary Source Emissions

Emissions	Lbs/Yr per Dwelling Unit
Particulates	2.7
Total Organics (HC)	45.8
Nitrogen Oxides (NO _x)	8.3
Sulfur Dioxide (SO ₂)	.5
Carbon Monoxide (CO)	24.0

Additional emissions may be ascribed to certain activities and to facilities directly or indirectly associated with residences--e.g: heating of local serving (non-basic) commercial, industrial and institutional facilities, gasoline stations, dry-cleaning plants, power-plants (excluding that proportion of power that is absorbed by basic industry), oil/gasoline refining and other industries (that portion of the product absorbed by local domestic consumers), pleasure powerboat use. However these induced emissions are not treated in detail here, because they usually do not produce significant local effects and the regional growth rates are included in source inventory projections.

Residential uses, as direct stationary sources, are usually not considered significant for planning or environmental impact assessment purposes. However, calculation of such emissions would be useful were there a desire to make a detailed estimate of the "environmental holding capacity" of a neighborhood, city, county, or sub-region. This might be the case if a system of area-by-area "emissions zoning" were to be contemplated--i.e. exclusion of uses that would directly or indirectly generate emissions at levels that lead to exceedances of air quality standards. Such a concept has been suggested in some regions with very critical air quality problems.

TABLE VI-C-2. CALCULATING PROJECT EMISSIONS--STATIONARY SOURCES*

GENERALIZED EMISSION FACTORS FOR SELECTED INDUSTRY GROUPS

Industry Group (Sub-groups)	Average Emissions per Facility (lbs/acre/day)				
	Part	ORG**	NO _x	SO ₂	CO
<u>Manufacturing</u>					
Food Canning (2032,2033)	.3	.5	19.	22.	2.2
Paper Products (2643,2647,2649,2653,2654)	.2	4.4	2.8	.01	.6
Printing & Publishing (2700-2771)	3.5	31.	42.	.2	6.0
Inorganic Chemicals (2812,2813,2816,2819)	1.6	.6	4.9	2.6	5.9
Paints, Varnishes, etc. (2851)	.2	20.	.5	.00	.1
Organic Chemicals (2861,2865,2869)	1.4	8.5	3.0	.5	1.6
Petroleum Refining (2911)	1.4	18.	26.	16.	1.3
Paving & Roofing (2951,2952)	17.	1.9	11.	.7	5.3
Plastic Products, Misc. (3079)	1.1	51.	.6	.00	.1
Stone, Clay, Glass & Concrete Products (3200-32990)	14.	2.4	17.	4.6	3.0
Iron & Steel Foundries (3321,3324,3325)	11.	44.	5.0	2.8	23.
Metal Containers (3411,3412)	.5	90.	5.5	.03	.8
Heating Equipment (3433)	.1	2.7	.2	.00	.03
Metal Work (3443,3444,3448,3449)	5.3	11.	1.3	.01	.2
Metal Coating (3471,3479)	.3	13.	.8	.00	.1
Machinery, except electrical (3500-3599)	72.	23.	.5	.02	.1
Semiconductors, etc. (3674)	.1	32.	.3	.01	.1
Electronic Components (3679)	.1	5.6	.1	.00	.02
Instruments (3800-3873)	.3	23.	1.4	.01	.2
<u>Other</u>					
Electric Utility plus Other Services (4931)	17.	12.	410.	78.	32.
Petroleum Bulk Stations & Terminals (5171)	.01	150.	.1	.02	.01
Dry Cleaning Plants (7216)	.00	6.6	.1	.00	.01
General Hospitals (8062)	2.9	2.3	30.	.2	6.0
National Security (9711)	2.8	2.5	22.	.01	5.5

*Based on U.S. Standard Industrial Classification (S.I.C.) Code groupings. As compiled by the Statistical Policy Division, Office of Management and Budget.

**Table lists total organic emissions (TOG). Reactive organics (ROG) is virtually the same for the industrial categories.

D. Construction Operations Emissions¹

General. Heavy construction is a source of dust emissions that may have substantial temporary impact on local air quality. Building and road construction are the prevalent construction categories with the highest emissions potential. Emissions during the construction of a building or road are associated with land clearing, blasting, ground excavation, cut and fill operations, and the construction of the particular facility itself. Dust emissions vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing weather. A large portion of the emissions result from equipment traffic over temporary roads at the construction site.

Emissions and Correction Parameters. The quantity of dust emissions from construction operations are proportional to the area of land being worked and the level of construction activity. Also, by analogy to the parameter dependence observed for other similar fugitive dust sources, it is probable that emissions from heavy construction operations are directly proportional to the silt content of the soil (that is, particles smaller than $75\text{ }\mu\text{m}$ in diameter) and inversely proportional to the square of the soil moisture, as represented by Thornthwaite's precipitation-evaporation (PE) index.

Emission Factor. Based on field measurements of suspended dust emission from apartment and shopping center construction projects, an approximate emission factor for construction operation is:

1.2 tons per acre of construction per month of activity.

This value applies to construction operations with: (1) medium activity level, (2) moderate silt content (approx. 30 percent), and (3) semiarid climate (PE approx. 50). Test data are not sufficient to derive the specific dependence of dust emissions on correction parameters.

The above emission factor applies to particles less than about $30\text{ }\mu\text{m}$ in diameter, which is the effective cut-off size for the capture of construction dust by a standard high-volume filtration sampler, based on a particle density of 2.2 to 2.5 g/cm³.

Control Methods. Watering is most often selected as a control method because water and necessary equipment are usually available at construction sites. The effectiveness of watering for control depends greatly on the frequency of application. An effective watering program (that is, twice daily watering with complete coverage) is estimated to reduce dust emission by up to 50 percent. Chemical stabilization is not effective in fill operations. Chemical stabilizers are useful primarily for application on completed cuts and fills at the construction site. Wind erosion emissions from inactive portions of the construction site can be reduced by about 80 percent in this manner, but this represents a fairly minor reduction in total emissions compared with emissions occurring during a period of high activity.

¹Based on EPA: Compilation of Emissions (AP-42) Sec. 11.2.4.

Thus, with emission control:

Residential, Commercial and Industrial Construction (with 50% control):

0.6 tons per acre per month

Road Construction (with 75% control):

0.3 tons per acre per month.

In addition to particulate emissions from earth moving, there are usually emissions of a number of contaminants from fuel burned by construction equipment. Usually such equipment is diesel fueled. Based on an estimate of .27 gallons of diesel fuel burned for cubic yard of earth excavated, the following emission rates would apply:

TABLE VI-D-1. DIESEL CONSTRUCTION EQUIPMENT EMISSION RATES

grams per cubic yard

Contaminant	g/yd ³ *	g/gallon**
TSP	2.6	9.6
CO	11.2	41.5
HC	6.1	22.6
NO _x	42.9	158.9
SO _x	4.9	18.1

*In grams per cubic yard.

**In grams per gallon of diesel fuel.

Building construction, as differentiated from earth moving in site preparation, varies greatly from project to project. If it is possible to estimate gallons of diesel fuel to be burned during construction, the second column of the above table can be used in calculating project emissions.

VII. AIR QUALITY IMPACT (MODELS AND CALCULATIONS)

A. Introduction

The BAAQMD system of Advisory Review of Projects and Plans, in cooperation with ABAG and MTC, is described in the 1982 Bay Area Air Quality Plan--a plan approved by the California Air Resources Board and the United States Environmental Protection Agency. The advisory review system recommends that lead agencies--cities and counties--and their consultants quantify the air quality impact of a project or plan which meets or exceeds specified threshold sizes (see Chapter III).

For local pollutants, such as carbon monoxide, a full analysis would include modeling to predict concentrations of the pollutant, currently and in the future if the project is built. Predicted concentrations of carbon monoxide are then compared with national and State air quality standards.

For any source, larger than the specified threshold size, which generates or attracts vehicular traffic, it is expected that the "indirect source" impact of vehicular emissions will be modeled. A prerequisite for such modeling is a traffic and transportation analysis.

Dispersion Models

Assessment of the air quality impact of projects with significant emission potential generally requires the use of some kind of dispersion model. In the simplest terms, a dispersion model can be described as a method of converting emissions (e.g. in grams per minute or grams per mile) into ambient pollutant concentrations (e.g. in parts per million of ambient air or, for particulates, in micrograms per cubic meter of ambient air).

The function of any dispersion model is to estimate the potential for a proposed project to impact applicable national, state, or local ambient air quality standards, before the project is constructed. Model results require some degree of interpretation, which can lead to several different conclusions depending on existing ambient air quality and the severity project impact:

- 1) If the proposed project should have an insignificant impact on ambient air quality standards - mitigation measures are not required. They may, however, be desirable because of other considerations, such as traffic flow, noise, aesthetics, etc.
- 2) If the proposed project should approach a significant impact on ambient air quality standards or, together with other nearby projects, would contribute to a significant impact but would not cause air quality standards to be exceeded - mitigation measures, if available, should be applied;
- 3) If the proposed project would have a significant impact on ambient air quality standards and would cause or contribute to a continuing violation of air quality standards--mitigation measures are strongly recommended. If measures are unavailable or insufficient to mitigate the emissions, the project's size, scope, emission controls, etc. should be reevaluated and/or alternatives

to the project or denial of local permit approval should be considered. The model may have to be run at least twice to reveal ambient air quality with and without the application of mitigation measures.

Dispersion models can be divided into two general categories: non-reactive and reactive. Non-reactive models are typically used for relatively inert pollutants such as carbon monoxide (CO), particulate matter (PM), and sulfur dioxide (SO₂). Reactive models are used for reactive pollutants such as oxides of nitrogen (NO_x) and reactive hydrocarbons (RHC), as precursors to nitrogen dioxide (NO₂) and ozone (O₃). For the purposes of these GUIDELINES the discussion of dispersion models is limited to non-reactive models.

There are a number of simple Gaussian dispersion models (CALINE3 and CALINE4, HIGHWAY, PTPLU, PTMAX, PTMTP, and PAL) which can be easily applied to projects involving stationary or mobile sources, or both. These models typically treat emission sources as point (smoke stack), area (fugitive or multiple points), or line (mobile). Most projects will include either line or point sources, or both.

An example of a project involving line sources is the construction of a new road or freeway segment, or a new housing development or shopping center which would generate increased traffic on existing roads or freeways. The EPA model, HIGHWAY, is appropriate for the analysis of road or freeway segments, but not intersections. CALINE3, CALINE4 and our screening model derived from them will accommodate both road/freeway segments and intersections.

Some examples of projects involving point sources are the construction or expansion of an oil refinery, auto assembly plant, and electric power plant. The EPA models PTPLU, PTMA, PTMTP, and PAL are applicable to point sources. PTPLU and PTMAX calculate the maximum ground level concentrations (one hour average) resulting from a single point source, for a variety of wind speed and weather conditions. PTMTP and PAL can accommodate multiple point sources; PAL also handles area and line sources.

These GUIDELINES provide highly simplified and condensed versions of line source and point source screening models. They are designed for use without the aid of a computer. More detailed models, such as CALINE4 for indirect sources, should be used for large projects--i.e. those which exceed Category C thresholds in Table IX-B-3.

B. Indirect Source (Screening) Model

These GUIDELINES provide a very simplified, normalized version of a model for estimating carbon monoxide pollutant concentrations from motor vehicle traffic associated with any plan or project. The formula given is based on CALINE3 and CALINE4 models developed by the California Department of Transportation, as scaled to agree with hot-spot analysis findings of field studies undertaken by BAAQMD.

Motor vehicle emission rates are, of course, a major input to the model. Emission rates, as inputs into the screening model, can be determined, for current and future years, from Table VI-B-2. The rates are in terms of grams per vehicle mile by average speed of travel and by year. The tabled

values are based on the EMFAC6D emission factors developed by the CARB. The carbon monoxide emissions are carried over to Table VII-B-1.)

The version given here includes "default values"--e.g. worst-case meteorological conditions found in the San Francisco Bay Area. Factors are introduced for receptors at the road edge, for more distant receptors, and for depressed and elevated roadways. If, for any project or plan, particular critical input values are known to differ from these normalized values--e.g. different wind direction relative to the road, atmospheric stability class (related to the vertical mixing of the air), wind speed, etc.--it is suggested that the full CALINE3 or CALINE4 Model be executed. This may also be useful where the screening model reveals concentrations very close to, or exceeding, ambient air quality standards. The full model--obtainable from CARB or CALTRANS--should give more precise results.

General Procedure for Carbon Monoxide Analysis

The following procedure is designed to provide a reasonable estimate of the carbon monoxide concentrations near roads under worst case conditions. It is a simplified version of CALINE3 and CALINE4. It is suggested that the full CALINE3 or CALINE4 models be used, instead of this simplified formula, for any projects or plans that will generate 10,000 or more motor vehicle trips per day, or equivalent units of land use activities at or above Category C threshold levels, Table IX-B-3. It may also be prudent to employ the full CALINE3 or 4 model for smaller projects in order to secure confirmation if the simplified screening model runs indicate that an air quality standard probably will be exceeded.

In the Bay Area highest CO concentrations occur in winter, usually on cold, clear days and nights with little or no wind. Low wind speeds inhibit horizontal dispersion and radiation inversions inhibit vertical mixing. For modeling, the worst case conditions are built into the simplified model formula for small projects. Default conditions are:

1. wind direction parallel to the primary roadway, 90° angle to secondary road;
2. wind speed less than 1 meter per second;
3. extreme atmospheric stability (class F);
4. receptor at edge of the roadway.

The carbon monoxide concentration, C , is the sum of a background value, C_0 , and the total contribution from local traffic, C_t ,

$$C = C_0 + C_t \quad (1)$$

The contribution from one road, C_i , can be computed by the formula:

$$C_i = C_{ri} \times \frac{VPH_i \times EF_i}{VPH_r \times EF_r} \quad (2)$$

where:

C_{ri} is a reference case concentration for the i-th roadway,

VPH_r is the traffic volume for the reference case,

VPH_i is the traffic volume for the i-th roadway,

EF_r is the emission factor for the reference case,

EF_i is the emission factor for the i-th roadway,

Table VII-B-2 gives reference case concentrations for various road configurations with traffic volumes of 1000 vehicles per hour and emission factors of 100 grams per mile. The concentration relative to this reference case is then computed in parts per million (ppm), by the formula:

$$C_i = \frac{C_{ri} \times VPH_i \times EF_i}{100,000} \quad (3)$$

where C_{ri} is taken from Table VII-B-2, VPH_i is the estimated traffic volume in vehicles per hour, and EF_i is the emission factor taken from Table VII-B-1 for the appropriate year of analysis and estimated traffic speed on this roadway.

Step by Step Procedure for CO Analysis

Make separate computations for current situation, future no-project situation (including cumulative), and future project situation--for each alternative project, for selected future year(s). Model also to show the effects of mitigation measures where such effects are quantifiable.

- 1) Identify intersections and/or road links which will be most impacted by the proposed project, according to the traffic impact analysis. An analysis should be made for each such intersection and link. (It would be helpful to include a map showing these points, in relationship to the project.) Future target dates should be chosen based on the present schedule and final build-out.
- 2) Obtain peak-hour traffic volume in both directions on each roadway considered per each year of consideration. If only Average Daily Traffic is known, see Table VI-B-1, Recommended Peaking Factor, 1-Hr. For land uses not listed, estimate 10% for peak hour. (Use actual traffic counts, if known, for current year. Traffic levels for future years should include traffic generated by the proposed project plus other estimated growth distributed among road links.
- 3) Estimate average traffic speeds through the intersection for peak-hour on each roadway. (If future congestion is predicted, average speeds will decrease in future years.)
- 4) Obtain the CO emission factor for each roadway, for each relevant year from Table VII-B-1. (Interpolate if necessary.)

- 5) Determine number of lanes and types of each roadway. (Do not count turning or parking lanes. If road is to be altered, use appropriate width for the years in question.)
- 6) Obtain the Reference 1-Hour Concentration for each roadway from Table VII-B-2. (The road with the most traffic should be considered the "Primary Road".) Be careful to use the proper reference factor in the table if the receptor is not at the edge of the road or if one or both of the roadways is elevated or depressed.
- 7) Compute each roadway's contribution to the total concentration by use of the equation above; if at intersection, add concentrations of the two (or more) roadways.
- 8) Add total roadway (local) contribution to the 1-hour background value from the background map (Figure V-B-2 or V-B-4, depending on year) to obtain the estimated worse case concentration. Interpolate by judgment between isopleth lines and interpolate or extrapolate (Table V-B-2) the background value for the appropriate year. Use caution in fine-tuning for background value, as discussed on page V-2.
- 9) To obtain the worstcase 8-hour value, multiply the 1-hour value for the local contribution by 0.7 (empirical ratio). Add this derived 8-hour local contribution to the background level on the 8-hour map (Figure V-B-3 or V-B-5). Interpolate or extrapolate (Table V-B-2) the background value for the appropriate year using caution in fine-tuning.

"Direct impact of the project" would be defined as the concentration level of the project case, minus the level of the no-project case, for any selected year, for any selected alternative. (Background level would be the same for all cases in the same year unless, of course, the site differs among alternative projects.) To quantify reductions due to mitigation measures, it will be necessary to estimate the effects of the measures in terms of changes in traffic volumes and/or speeds. The difference between the modeled concentrations with and without mitigation measures will, obviously, indicate the air quality benefits attributable to the mitigations.

Example Calculation

Analysis Year: 1985

Situation: Intersection of 6-lane highway and a 4-lane road at grade level.

Background 1-hour CO concentration is 12.0 ppm.

8-Hour CO Concentration is 8.8 ppm

	<u>Primary Road</u>		<u>Secondary Road</u>	
Hourly Traffic Volume	3400		2700	
Average Speed	25 mph		15 mph	
Equation	$\frac{3400 \times 19 \times 9.5}{100,000}$		$\frac{2700 \times 28 \times 3.3}{100,000}$	
1-Hr Local Concentration:	6.1	+	2.5	=
8.6 ppm				
1-Hr Total Concentration:	8.6 (intersection) + 12.0 (1-hr background) =			
20.6 ppm				
8-Hr Local Concentration:	8.6 x .7 = 6.0 ppm			
8-Hr Total Concentration:	6.0 (intersection) + 8.8 (8-hr background) =			
14.8 ppm				

TABLE VII-B-1 COMPOSITE MOTOR VEHICLE EMISSION FACTORS FOR CARBON MONOXIDE
(in grams per mile)

Year	Average Speed (miles per hour)											
	5	10	15	20	25	30	35	40	45	50	55	60
1985	72	40	28	21	19	16	14	12	12	11	11	10
1990	49	27	20	16	13	11	10	9	8	8	8	6
1995	42	23	17	13	11	10	18	7	7	7	6	5
2000	40	22	16	13	11	9	8	7	7	7	6	5

Source: EMFAC6D, adjusted for Inspection and Maintenance program
(see: Table VI-B-2)

TABLE VII-B-2. REFERENCE CARBON MONOXIDE CONCENTRATIONS (ppm)

Roadway Type		Primary Road					Secondary Road					
(Intersection at grade)		(Most trafficked Road					(Intersecting) Road					
		(at the edge of an urban roadway)										
2 lane		14.0					3.7					
4 lane		11.9					3.3					
6 lane		9.5					2.8					
8 lane		8.5					2.6					
(perpendicular receptor distance from edge--in feet)												
(at grade)	at edge	25'	50'	100'	300'	500'	at edge	25'	50'	100'	300'	500'
2 Lane	see	7.6	5.7	4.0	1.7	0.9	see	2.7	2.2	1.7	1.0	0.8
4 Lane	above	7.0	5.4	3.8	1.6	0.9	above	2.6	2.2	1.7	1.1	0.8
6 Lane		6.1	4.9	3.5	1.6	0.8		2.3	2.0	1.7	1.1	0.9
8 Lane		5.7	4.6	3.4	1.5	0.8		2.2	1.9	1.6	1.1	0.9
(Depressed 15 feet)												
2 Lane	20.9	8.2	4.7	3.3	1.5	0.8	4.8	2.4	1.4	1.1	0.8	0.5
8 Lane	15.4	6.3	3.6	2.7	1.3	0.7	3.7	1.9	1.1	1.0	0.7	0.6
(Depressed 30 feet)												
2 Lane	26.8	7.9	3.4	1.7	0.8	0.3	5.2	3.2	2.0	0.8	0.4	0.3
8 Lane	21.3	6.0	2.3	1.1	0.6	0.2	4.1	2.7	1.7	0.7	0.5	0.4
(Elevated 15 feet)												
2 Lane	14.0	7.3	5.7	4.0	1.7	0.9	3.7	2.6	2.2	1.7	1.0	0.8
8 Lane	8.5	5.4	4.6	3.4	1.5	0.8	2.6	2.1	1.9	1.6	1.1	0.9
(Elevated 30 feet)												
2 Lane	14.0	7.3	5.4	4.0	1.7	0.9	3.6	2.6	2.2	1.7	1.0	0.8
8 Lane	8.5	5.4	4.3	3.4	1.5	0.8	2.5	2.1	1.9	1.6	1.1	0.9

Notes: Normalized CO concentration is calculated with the assumptions on page VII-3, plus: emission rate = 100 gm/mi; vehicles per hour = 1,000; surface roughness = 100 cm; mixing cell width = roadway width (2 Lane = 40 ft; 4 lane = 64 ft; 6 lane = 88 ft; 8 lane = 112 ft).

This simplified model, with worst case inputs, was adapted from CALINE3 and CALINE4 (California Department of Transportation) by Mike Kim, Senior Transportation Engineer, BAAMQD.

Suspended Particulates

At this time (late 1985) it is not required that cities and counties estimate particulate concentrations resulting from motor vehicle emissions. Standards have been changed to focus on very small particles (less than 10 micrometers in diameter--PM₁₀) which pose the greatest threat to health. However, research results have not as yet been published which document the emissions levels of such particulates from motor vehicle exhausts and tire wear or from resuspension of dust from roads by vehicle movement. When such material is available, a new modeling section will be added to these GUIDELINES.

Total Emissions from Indirect Sources

In addition to estimating concentrations of local contaminants--such as CO--at impacted intersections or beside a roadway, total emissions should be calculated for all criteria pollutants from motor vehicle trips generated by the project. For this calculation it is necessary to include estimates of average trip length and trip generation rates, as well as emissions per mile based on speed and year of concern, plus a correction factor for cold starts and hot starts.

The simple formula is:

$$E = U \times T \times L \times R \times C$$

where:

E equals total emissions, in grams per day;

U equals number of units in the project, e.g. number of dwelling units, thousands of square feet in shopping center buildings (see units in Table VI-B-1);

T equals average trips per day generated per unit of land use (Table VI-B-1);

L equals average trip length, in miles per trip (Table VI-B-1);

R equals motor vehicle emission rate, for each criteria contaminant, in chosen year, at estimated average speed (Table VI-B-2).

C equals cold start/hot start correction factor for carbon monoxide, hydrocarbons and nitrogen oxides (Table VI-B-3).

Idle Time Emissions

If idling time per trip can be estimated and is substantial, add idle time emissions. Then total emissions would be:

$$\text{Total Emissions} = E + (I \times r \times U \times T)$$

where:

I equals average idle time emissions per trip, in minutes;

r equals idle emission rate, in grams per minute (Table VI-B-2.1).

Comparative Analysis

Grams-per-day may be converted into tons-per-day by dividing by 908,000. The tons per day computation can then be compared (as a percentage) with:

- a) total emissions for that contaminant from the Bay Area District Inventory for the year in question (Table VI-A-2 or interpolation for other years)
- b) motor-vehicle-generated emissions for that contaminant (Table VI-A-2),
- c) county emissions of that contaminant (Table VI-A-1, scaled to totals in Table VI-A-2 for the year in question),
- d) transportation-related emissions from county (Table VI-A-1, scaled).

Example: Find and compare total indirect-source reactive hydrocarbons estimated from a planned multi-use project which would be completed in Solano County in 1990.

<u>Use</u>	<u>Units</u>	<u>Trip Generation</u>	<u>Trip Length</u>	<u>Emission Rate</u>	<u>Correction Factor</u>	<u>grams/day</u>
Single Family Homes	1000 d/u	10.0 tpd	6.2 mpt	1.48 gpm	1.03	94513
Apartments	2000 d/u	5.7	6.2	1.48	1.03	107745
Shopping Center	200 thou sq ft	40.0	5.0	1.48	1.27	75184
Offices	300 thou sq ft	15.0	6.2	1.48	1.18	48725
Industrial Park	150 acres	77.0	9.6	1.48	.93	152615
						478782

478782 grams per day divided by 908000 = .53 tons per day

% of District (.53 ÷ 511) = 0.10%

% of motor-vehicle generated in District (.53 ÷ 143) = 0.37%

% of county (.53 ÷ (31 × $\frac{511}{615}$)) = 2.06%

% of county transportation-generated (.53 ÷ (17 × $\frac{511}{615}$)) = 3.75%

Note: A further refinement of estimates of total emissions generated from a

proposed project can be obtained through utilization of the URBEMIS model, available from the California Air Resources Board. Use of the full URBEMIS model makes explicit the differences among land uses in the ratio between hot and cold starts of motor vehicles, the hot-stabilized period and--in the case of hydrocarbons--the hot-soak period after the motor has been shut off. We recommend use of the full URBEMIS model to calculate total emissions from projects or plans that will generate 10,000 or more motor vehicle trips per day, or equivalent units of land use activities at or above Category C threshold levels, Table IX-B-3. If URBEMIS is applied, we suggest that trip generation rates and average trip lengths be based on Bay Area data, as in Table VI-B-1. As presently drafted, URBEMIS applies trip generation rates slightly different from those in these tables and is not sensitive, in all input factors, to differences in trip lengths according to land use.

C. Impact Analysis of Point Sources

Following are two simplified models for estimating the worst-case concentrations, at chosen receptor points, of emissions of any known contaminants from smokestacks or flues. One applies to level terrain, the other to elevated terrain.

These models apply to single points of emissions. Where there is more than a single point of emissions, the models should be run for each emission point. The cumulative impact on any receptor point can be derived from simple addition of all single source impacts.

Where there are so many emissions points that each can not be calculated separately--e.g. in the case of a large oil refinery, a large multi-flue electronics fabricating plant, or tank farm with fugitive emissions from tanks--a more complex model is required. Such models as CRSTER, ISC and COMPLEX I would apply. These situations usually occur in cases of large, complex facilities. It is expected that the analysis would be undertaken by experienced air pollution analysts with access to the computerized models. Therefore the models are not reproduced in these GUIDELINES.

Procedure for Point Source Impact Estimation

1. Identify all sources (associated with the project) at which pollutants are emitted from a stack or flue, or as fugitive emissions.
2. Determine the emission rate for each of the above point sources, in pounds per hour, for full capacity operation, and for each of the pollutants for which a standard has been promulgated.
3. For each point source found to be emitting in excess of 10 pounds per hour of any pollutant under capacity operating conditions, fill out the computation sheet (Figure VII-C-1).

Assumptions

The calculations performed on the computation sheet are designed to provide a reasonable estimate of the maximum ground level concentration resulting from stack emissions over various averaging times under adverse¹ operating and meteorological conditions. Adverse operating conditions are assumed as operation at full capacity and the calculation is to be performed using the full capacity emission rate. Adverse meteorological conditions are assumed to consist of a Turner B stability category with a 2 meter per second wind speed. Plume rise is calculated using the Briggs formulas at a distance of 10 stack heights downwind. With these input assumptions, the result of the calculation is assumed to represent the maximum 1-hour averaged concentration downwind. Conversion of the 1-hour concentration to other averaging times is based on ratios derived from experience. The model on which the calculations are based is a Gaussian point source model.

¹Adverse conditions are those which may reasonably be expected to occur at least once in the course of a year and which, when they occur, are conducive to high concentrations of emitted pollutants downwind from the stack.

Project: _____

Pollutant: _____

FIGURE VII-C-1. COMPUTATION SHEET

Point Source Impact Computation Sheet
(numbers in circles indicate previous entries)

Point source code number _____ (reference project site plan)

Calculation of plume rise and concentration-source strength ratio

Emission point orifice height above grade 1) _____ m
 Orifice inside diameter 2) _____ m
 Gas exit temperature (at orifice) 3) _____ °K
 Gas exit velocity (at orifice) 4) _____ m-sec⁻¹
 Temperature difference parameter (1 - (298 ÷ ③)) 5) _____
 Buoyancy factor (2.4 x ④ x ②² x ⑤) 6) _____ m⁴-sec⁻³
 Plume rise (14 x ⑥^{1/3}) 7) _____ m
 Effective stack height (① + ⑦) 8) _____ m
 Downwind distance to concentration maximum (7 x ⑧) 9) _____ m
 Concentration-source strength ratio (from Fig. VII-C-2)...10) _____ μg/m³
 Percentage frequency of wind from indicated directions: _____ gm/sec
 N _____ NE _____ E _____ SE _____ SW _____ W _____ NW _____ Calm _____

Calculation of maximum ground level impact

Peak emission rate for sustained operation over the indicated averaging times in units of grams per second.

1 hr 3-hr 8 hr 24-hr 1-yr

(11) (12) (13) (14) (15)

Ground level maximum concentration for various averaging times calculated as ⑩ multiplied by pollutant source strength and, in turn, multiplied by the averaging time conversion parameter, $\frac{m}{\mu g/m^3}$. Enter in 16-20 below.

Averaging time conversion parameters = $\frac{m}{\mu g/m^3}$
 1-hr 3-hr 8-hr 24-hr 1-yr
 m=1.0 m=0.9 m=0.7 m=0.4 m=0.1

Pollutant concentration for appropriate averaging times

16) $\frac{\mu g}{m^3}$ (1-hr) 17) $\frac{\mu g}{m^3}$ (3-hr) 18) $\frac{\mu g}{m^3}$ (8-hr) 19) $\frac{\mu g}{m^3}$ (24-hr) 20) $\frac{\mu g}{m^3}$ (1-yr)

Graphical estimation of concentration-source strength ratio at the point of ground level maximum as a function of effective stack height under adverse meteorological conditions.

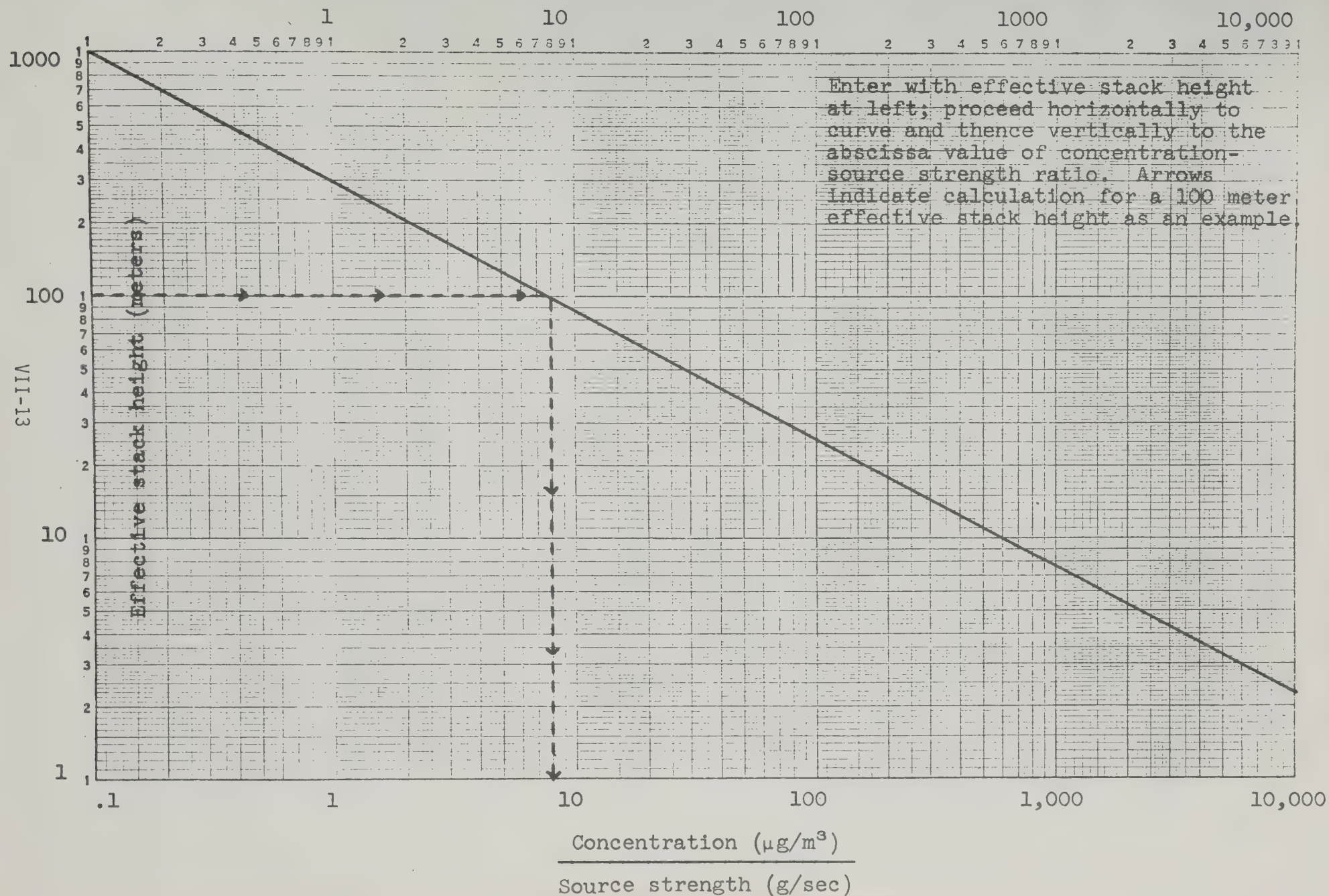


Figure VII-C-2. Source Strength Ratio--Graphical estimation of concentration

TECHNICAL BASIS FOR COMPUTATION SHEET

The purpose of this computation sheet is to estimate the ground level concentration from a buoyant point source plume under operating and meteorological conditions which might reasonably be assumed to cause relatively high, if not "worst," concentrations.

Entries ① through ④ provide the standard stack characteristics used in computing the rise of buoyant plumes above the height of a stack orifice. Entry ⑤ provides a parameter based on the difference between stack gas and ambient temperature, related to buoyancy and calculated as:

$$(T_s - T_a) \div T_s = 1 - (T_a \div T_s) = P_t \quad (1)$$

For this calculation an ambient temperature of 25 degrees centigrade converted to 298 degrees Kelvin is used.

Entry ⑥ is a buoyancy factor calculated as:

$$F = gQ_H / \pi \rho C_p T_s \quad (2)$$

$$= \frac{gQ C_p (T_s - T_a)}{\pi \rho C_p T_s}$$

(3) This derivation is performed in order to express the physical concept of buoyancy in terms of the most commonly used parameters of gas flow: gas exit temperature, velocity and physical characteristics of the stack configuration.

$$= \frac{gQ}{\pi \rho} \frac{(T_s - T_a)}{T_s}$$

(4) meters of gas flow: gas exit temperature, velocity and physical characteristics of the stack configuration.

$$= \frac{g(w\pi r^2 \rho)}{\pi \rho} \frac{(T_s - T_a)}{T_s} \quad (5)$$

$$= gwr^2 \frac{(T_s - T_a)}{T_s} \quad (6)$$

$$= \frac{gwd^2}{4} \frac{(T_s - T_a)}{T_s} \quad (7)$$

$$= 2.4 \left[\frac{m}{sec^2} \right] \times w \times d^2 \times \frac{(T_s - T_a)}{T_s} \quad (8)$$

or, in terms of computation sheet numbered entries,

$$= 2.4 \times (4) \times (2)^2 \times (5) \quad (9)$$

where: g = gravitational acceleration (9.8m/sec²)
 Q_H = flow rate of excess heat (cal/sec)
 ρ = density of exit gas (g/m³)
 C_p = specific heat at constant pressure (cal/g-°K)
 T_s = exit gas temperature (°K)
 T_a = ambient temperature (°K)
 Q = flow rate of mass (g/sec)
 w = exit gas velocity (m/sec)
 r = stack orifice radius (m)
 d = stack orifice diameter (m)
 π = 3.14

Entry (7) is plume rise calculated as:

$$\Delta H = 2.4 \left(\frac{F}{US} \right)^{1/3} \quad (\text{Ref. Briggs}) \quad (10)$$

where F is entry (6), U is wind speed (m/sec) and S is a stability parameter defined as:

$$S = \frac{g}{T_a} (\partial\theta/\partial z) \quad (\text{Ref: Briggs, p.27, eqn. 4.16}) \quad (11)$$

The lapse rate of potential temperature $\partial\theta/\partial z$, is assumed to be 0.0025°C/m, which represents a slightly stable lapse rate. Assuming also a wind speed of 2 m/sec, this becomes

$$\Delta H = 43.8 \left[\frac{\text{sec}}{\text{m}^{1/3}} \right] F^{1/3} = 43.8 \times (6)^{1/3} \quad (12)$$

Entry (8) is effective stack height calculated as the sum of orifice height, entry (1) and plume rise (7).

Entry (9) is the downwind distance from the stack to the point of maximum ground level concentration estimated from the effective stack height of entry (8) and Figure VII-C-2.

Entry (10) is the ratio of ground level maximum concentration (μg/m³) to mass emission rate at the source (g/sec) based on effective stack height (entry (8)), and a 2 meter per second wind speed.

Entries (11) through (15) are estimates of the average mass rate of emission from the source (g/sec) under peak operating conditions over the specified

time intervals.

Entries ①⑥ through ②① are statistical estimates of maximum ground level concentrations for various averaging times based on entries ①① through ①⑤ and empirical adjustments to entry ①⑩.

Where non-criteria toxic emissions are produced, a risk-assessment analysis is called for in addition to the above methods of analysis (Sections IV-B and VIII-B). Such an analysis would estimate the potential rate of persons harmed by the toxic emissions.

D. Concentration at Receptors on Elevated Terrain

Dispersion models developed for estimating maximum ground-level concentrations in complex terrain have not been adequately evaluated. However, there is growing acceptance of the hypothesis that greater concentrations can occur on elevated than on flat terrain in the vicinity of an elevated source. That is particularly true when the terrain extends well above the plume centerline (plume height).

A procedure is presented here to (1) determine if an elevated plume may intercept terrain and, if terrain is likely to be intercepted, (2) estimate the maximum 24-hour concentration. The procedure is based largely upon the 24-hour mode of the EPA VALLEY Model. A concentration estimate obtained through the procedure will likely be somewhat greater than provided by the VALLEY Model, primarily due to the relatively conservative plume height that is used in Step 1:

Step 1. Determine if the plume is likely to intercept terrain in the vicinity of the source:

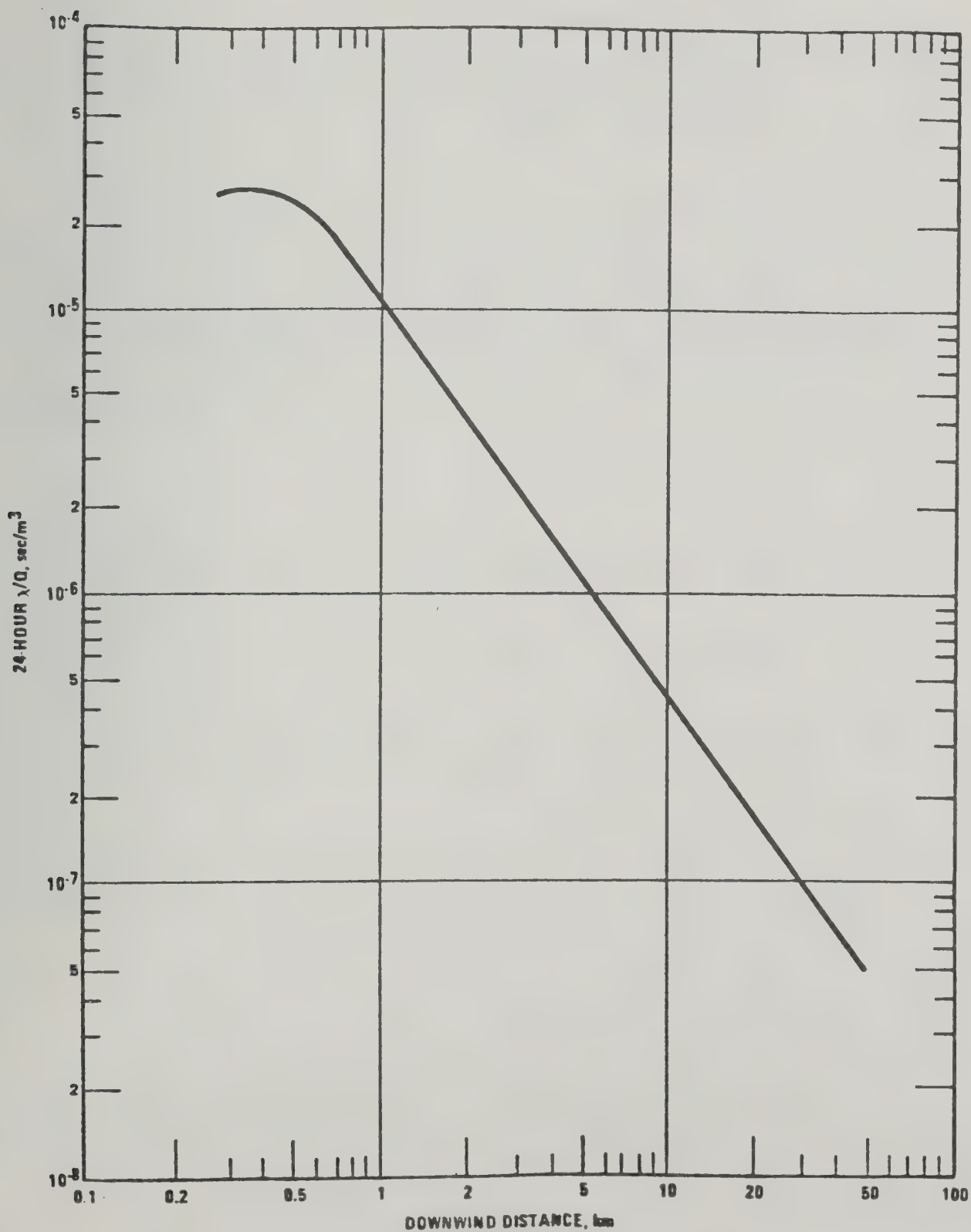
(1) Compute one-half of the plume rise ($h/2$) that can be expected during F stability and a wind speed (u) of 2.5 m/sec. (The reason for using only one-half the normally computed plume rise is to provide a margin of safety in determining (1) if the plume may intercept terrain and (2) the resulting ground-level concentration.):

$$h/2 = 1.2 \left[\frac{FT_a}{ug \frac{\Delta\theta}{\Delta z}} \right]^{1/3}$$

Definition of Terms.

$$\begin{aligned} F &= \frac{g}{4} w_s d^2 \left[\frac{T_s - T_a}{T_s} \right] \\ &= 3.12 V \left[\frac{T_s - T_a}{T_s} \right] \end{aligned}$$

Figure VII-D-1. 24-hour normalized concentrations χ/Q versus downwind distance, obtained from the Valley Model. Assumptions include stability class F, a wind speed of 2.5 m/sec, and plume height 10 meters above terrain.



where g = acceleration of gravity (9.8 m/sec^2)

w_s = stack gas exit velocity (m/sec)

d = inside stack diameter (m)

T_s = stack gas temperature ($^{\circ}\text{K}$)

T_a = ambient air temperature ($^{\circ}\text{K}$) (If no ambient temperature data are available, assume that $T_a = 293 \text{ }^{\circ}\text{K}$.)

V = actual stack gas flow rate (m^3/sec)

The value $\frac{\Delta\theta}{\Delta z}$ is the change in potential temperature with height. If typical values of $\frac{\Delta\theta}{\Delta z}$ are not known for the site, a value of $0.02 \text{ }^{\circ}\text{K/m}$ for E stability, and $0.035 \text{ }^{\circ}\text{K/m}$ for F stability may be used for sources with stacks less than about 100 m high. For stacks more than 100 m high, use $0.01 \text{ }^{\circ}\text{K/m}$ and $0.02 \text{ }^{\circ}\text{K/m}$ respectively.

(2) Compute a conservative plume height (H_c) by adding the physical stack height (h_s) to $h/2$:

$$H_c = h_s + h/2$$

(3) Determine if any terrain features in the vicinity of the source are as high as H_c . If so, proceed with Step 2. If that is not the case, the plume is not likely to intercept terrain, and Step 2 is not applicable.

Step 2. Estimate the maximum 24-hour ground-level concentration on elevated terrain in the vicinity of the source:

(1) Using a topographic map, determine the distance from the source to the nearest ground-level location at the height H_c .

(2) Using Figure VII-D-1 and the distance determined in (1), estimate a 24-hour X/Q value, $(X/Q)_{24}$.

(3) Multiply the $(X/Q)_{24}$ value by the emission rate Q (g/sec) to estimate the maximum 24-hour concentration X_{24} due to plume interception of terrain:

$$X_{24} = (X/Q)_{24} \cdot (Q)$$

E. Transport of Reactive Pollutants

The phenomena of down-wind transport and receptor concentrations of reactive pollutants can currently be estimated quantitatively only through the use of very complex and expensive modeling procedures. Receptor sites may be far from the source of emissions, even outside the air basin where the

For example, hydrocarbons and nitrogen oxides react in sunlight to form ozone, even as they are being transported by the wind. Nitric oxide can react in the atmosphere to become nitrogen dioxide, the yellow-brown gas that accompanies ozone and is the visible gas in smog. Nitrogen oxides and sulfur oxides are thought to be the main sources of acidity in the various forms of acid precipitation.

Because of the complexity and expense, given the current state of the art, we do not usually suggest that reactive transport modeling be undertaken. Nonetheless, environmental documents and plans for projects which would generate major amounts of reactive contaminants should contain estimates of the total emissions of each pollutant and at least a statement about potential effects on down-wind cities and regions.

Environmental documents for major stationary source projects--those which emit large amounts of contaminants, e.g., amounts which trigger New Source Review rules--may include models which trace the trajectory of the contaminants as well as their maximum ground impact and impact on nearby sensitive receptors. If the contaminants react in the atmosphere -- e.g., hydrocarbons, oxides of nitrogen -- a reactive model may be necessary. Models are "Urban Airshed", developed and operated by SAI, Inc. of San Rafael, and LIRAQ, developed by Lawrence Livermore National Laboratories in cooperation with BAAQMD.

VIII. ASSESSING THE SIGNIFICANCE OF AIR QUALITY IMPACTS

A. Definitions of Significance

The California Environmental Quality Act defines "significant effect on the environment" to mean "a substantial, or potentially substantial, adverse change in the environment" (CEQA Section 21068). This is elaborated upon in the CEQA Guidelines in the definition "...adverse change in any of the physical conditions within the area affected by the project including ... air ..." (Section 15382). As mentioned in Chapter II of these GUIDELINES, a significant air quality effect is cited as a project which will "violate any ambient air quality standard, contribute substantially to an existing or projected air quality violation, or expose sensitive receptors to substantial pollutant concentrations" (CEQA Guidelines Appendix G).

Operationally, from the point of view of the Bay Area Air Quality Management District, a project or plan which violates air quality standards or is estimated to lead to violations in the future, is recommended for mitigation or alternatives (or denial of approval) by the "lead agency". Ideally the mitigations and/or alternatives would reduce the impacts to the point where the project or plan would no longer lead to violations; it therefore would no longer be classified as of significant effect.

B. Measures of Significance

Test (1). The preceeding chapter of these GUIDELINES described a simplified method for estimating carbon monoxide concentrations from motor vehicle sources. Obviously any project or plan which--when added to background levels--would generate CO concentrations above the State or national CO standards (eight hour average of 9 parts per million) would be "of significant effect" by definition.

Test (2). Because modeling to arrive at concentration levels of other air contaminants from mobile sources is not called for, except for large projects, a surrogate quantitative standard is proposed. Emissions totals from motor vehicles for each suspect contaminant would be derived as described in the preceeding chapter. The level of emissions from a total of direct and indirect sources would be considered significant if any contaminant, other than carbon monoxide, equalled or exceeded the emissions levels set by BAAQMD to trigger Best Available Control Technology (BACT) requirements for a stationary source (Rule 2-2-301.1 of BAAQMD Rules and Regulations). These emissions levels are listed in Table VIII-A-1. For non-criteria pollutants classified as hazardous or toxic (Section IV-B), a risk-assessment should be conducted in addition to the standard analysis.

TABLE VIII-A-1. AIR CONTAMINANT EMISSIONS LEVELS CONSIDERED SIGNIFICANT FOR PURPOSES OF THESE GUIDELINES (BACT Threshold Levels)

	<u>Tons/Day</u>	<u>Lbs/Day</u>	<u>Kgms/Day</u>
Criteria Pollutants (emission rates from motor vehicles in Table VI-B-2)			
Hydrocarbons	.075	150	68
Nitrogen Oxides	.075	150	68
Sulfur Dioxide	.075	150	68
Particulates	.075	150	68
Carbon Monoxide*	.275	550	249
Non-Criteria Pollutants (emissions rates vary greatly by source)			
Lead		3.2	1.45
Asbestos		.04	.017
Beryllium		.002	.0009
Mercury		.5	.24
Vinyl Chloride		5.5	2.45
Fluorides		16	7.45
Sulfuric Acid Mist		38	17.4
Hydrogen Sulfide		55	24.8
Total Reduced Sulfur		55	24.8
Reduced Sulfur Compounds		55	24.8

*Carbon Monoxide levels which trigger BACT from stationary sources are listed. However, since CO emissions are to be modeled, this level of emissions is considered "of significant effect" for purposes of these GUIDELINES only if it leads to exceedance of concentration standards, or is produced by a stationary source.

Test (3). Any project or plan should also be considered of significant effect if emissions of any criteria contaminant from combined direct and indirect sources reaches or exceeds one percent (1%) of county emissions of the contaminant (compared to the county in which the project or plan will be). If emissions are solely from indirect sources the project or plan is to be considered significant if emissions levels equal or exceed one percent (1%) of the transportation-related emissions of the county (see pages VII-8 and VII-9).

Test (4). For point sources only - any stationary source where modeled concentration levels for any contaminant (see Chapter VII-C and Tables VIII-D-1 and VIII-D-2) equal or exceed standards is considered of significant effect.

Thus carbon monoxide is considered significant if the concentration level meets Test (1) or the stationary source emissions level meets Test (3), above. Other criteria contaminants are considered significant if they meet or exceed emissions levels of Test (2), Test (3), or Test (4).

Test (5). There is still another way in which a project or plan may be judged to be of significant effect. If the population or employment projections for the sub-region--as compiled in PROJECTIONS 83 or PROJECTIONS 85 by the Association of Bay Area Governments--would be exceeded because of the project or plan, there could be a finding of "lack of consistency or conformity with the Bay Area Air Quality Plan" (see also: Chapter X). That is, in itself, equivalent to a finding of significant adverse effect. Therefore mitigations should be introduced, alternatives chosen, or the project or plan denied local approval--unless, of course, the local governing body finds and issues a statement that there are overriding considerations, i.e. reasons to approve the plan or project even though it violates air quality standards.

C. Mitigation Measures Related to Significance

The next chapter explains which mitigation measures are recommended, depending on the type and size of the project, whether significance levels are reached, and to what degree they are exceeded. Any project or plan which meets the threshold levels of Chapter III is thought to be worthy of consideration for Category A mitigations. Any project or plan which meets the above test of significant effect is recommended for Category B mitigations in addition. Very large projects or plans, as quantitatively defined in the next chapter, are recommended for Category C mitigations (see Tables IX-B-3 and IX-B-4).

D. Air Quality Standards

Air quality standards are the ambient concentration levels above which health or material damage effects have been documented. The ambient air quality standards are set by EPA and ARB. They are related to human health and are goals to be met by air pollution control activities. The way society attempts to reach these goals is by controlling and limiting emissions from specific sources with meteorology taken into consideration.

TABLE VIII-D-1. COMPARISON OF FEDERAL AND STATE AIR QUALITY STANDARDS

Pollutant Averaging Time	Federal Primary	Standards Secondary	State Standard	Objective
Ozone 1-hour	0.12 ppm 240 ug/m ³	Same --	0.10 ppm 200 ug/m ³	To prevent eye irritation, breath- ing difficulties.
Carbon Monoxide 8-hour	9 ppm 10 mg/m ³	Same	9 ppm 10 ug/m ³	To prevent carboxyhemo- globin levels greater than 2%.
1-hour	35 ppm 40 mg/m ³	Same	20 ppm 23 mg/m ³	
Nitrogen Dioxide Annual	0.05 ppm 100 ug/m ³	Same	--	To prevent health risk and improve visibility.
1-hour	--	--	0.25 ppm 470 ug/m ³	
Sulfur Dioxide Annual	0.03 ppm 80 ug/m ³	-- --	-- --	To prevent increase in respiratory disease, plant damage & odor.
24-hour	0.14 ppm 365 ug/m ³	--	0.05 ppm 131 ug/m ³	
3-hour	--	0.5 ppm 1310 ug/m ³	--	
1-hour	--	--	.25 ppm 655 ug/m ³	
Sulfates 24-hour	--	--	25 ug/m ³	To improve visi- bility and prevent health effects.
Particulate Annual Mean	75 ug/m ³	60 ug/m ³	30 ug/m ³	To improve visi- bility and prevent health effects.
24-hour average	260 ug/m ³	150 ug/m ³	PM ₁₀ * 50 ug/m ³ PM ₁₀ *	
Visibility Reducing Particles	State Standard: One observation in sufficient amount to reduce the prevailing visibility to less than 10 miles when the relative humidity is less than 70%.			
Lead 30-day Calendar quarter	-- 1.5 ug/m ³	-- Same	1.5 ug/m ³ --	To prevent health problems.
Hydrogen Sulfide 1-hour	--	--	0.03 ppm 42 ug/m ³	To prevent odor problems.
Vinyl Chloride (Chloroethene) 24-hour	--	--	0.010 ppm 26 ug/m ³	To prevent health problems.

*PM₁₀ = Particulate matter ten microns or less in size.

Note: Primary standards are the levels of air quality necessary, with an adequate margin of safety, to protect the public health. Secondary standards are the levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

TABLE VIII-D-2. SUMMARY OF MOST RESTRICTIVE AMBIENT AIR QUALITY STANDARDS

CRITERIA POLLUTANTS	AVERAGING TIME	APPLICABLE STANDARD* (Not to be equalled or exceeded)
Ozone	1-Hour	0.10 ppm
Carbon Monoxide	8-Hour 1-Hour	9. ppm** (F) 20. ppm***
Nitrogen Dioxide	Annual Average 1-Hour	0.05 ppm (F) 0.25 ppm
Sulfur Dioxide	Annual Average 24-Hour 1-Hour	0.03 ppm (F) 0.05 ppm 0.25 ppm***
Suspended Particulate	Annual Geo Mean 24-Hour	30. $\mu\text{g}/\text{m}^3$ PM ₁₀ *** 50. $\mu\text{g}/\text{m}^3$ PM ₁₀ ***
Lead	30-Day Average	1.5 $\mu\text{g}/\text{m}^3$
Sulfates	24-Hour	25. $\mu\text{g}/\text{m}^3$
Hydrogen Sulfide	1-Hour	0.03 ppm
Vinyl Chloride	24-Hour	0.01 ppm
Visibility Reducing Particles		In sufficient amount to reduce visibility to less than 10 miles when relative humidity is less than 70%.

*Applicable standard is defined as the most stringent among the Federal primary standard, the Federal secondary standard and the California State standard.

**Federal standard, not to be exceeded if annual average; not to be exceeded more than once per year for other averages.

***California standard which may not be equalled or exceeded.

(F)=Federal standard; no letter following the standard means that it is a State of California standard.

E. Cumulative Effects

The CEQA Guidelines definition of "cumulative impacts" include: "the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonable foreseeable probable future projects." It goes on to state: "The discussion ... should be guided by a standard of practicality and reasonableness."

We believe that cumulative impacts should always be included in environmental assessments of projects in areas that are undergoing rapid growth or which have a strong potential for continued growth. Local environmental review officials will want to assure that all environmental documents, including initial studies, take into account the relationship between the project in question and other potential projects. "Other projects" include, at a minimum, those known from permits, permit applications, environmental documents and planner's discussions with probable future developers.

However, in California, and especially in the San Francisco Bay Area with its relative sophistication in land use planning, local planners are often in a position to make judgments beyond this minimum. They often have enough information, analyses, and projection studies to be able to estimate extent, use, density, rate of fill-out and similar factors concerning the probable future of development of any sub-area in their sphere of influence.

Such time-related projections make it possible to estimate the amount of future uses and to model future traffic generation. This, combined with projected air-contaminant emissions rates from indirect and direct sources--as given elsewhere in these GUIDELINES--allows an analyst to forecast total future emissions and model future concentrations of contaminants.

Thus we believe that, where possible, cumulative impact analysis should include impacts of all probable future developments nearby, within an appropriate time-frame, not only those for which permit or environmental documents happen to be in process at the time of assessment.

Such a cumulative impact analysis should be an integral part of the environmental assessment of any project within, or near, a developing area. The concept may also be carried into the formulation of master environmental impact reports and air quality elements in general and specific-area plans.

IX. LOCAL GOVERNMENT GUIDE TO PROJECT MITIGATION AND OTHER IMPROVEMENT MEASURES FOR AIR QUALITY

A. General Comments

This chapter is intended as a guide for local government planners and other local officials in the San Francisco Bay Area. It concerns the actions that cities and counties can take both to mitigate air quality impacts of development projects they approve, and to improve air quality through non-project local actions. In preparing this chapter, the District reviewed a number of sources including local, regional, state and federal government publications (cited under Bibliography). Since the chapter is directed toward Bay Area local officials, the District has tried to select measures of greatest applicability and potential for this user group.

With few exceptions, the measures listed and described below serve to mitigate or avoid air pollution from motor vehicles rather than from industrial sources. (Emissions from stationary sources, including industrial processes are controlled directly through the BAAQMD permit, inspection and enforcement procedures.) These suggested measures are not technological in nature; they are related to land use and transportation planning, regulation and management. Their purpose is to reduce vehicle trips, vehicle miles traveled, and pollutant emissions per vehicle mile (cold-start trips emit more pollutants than hot-start trips); and thereby to reduce the emission of automobile-related air pollutants on both a regional and localized basis. (Trips which begin as "cold starts" emit more pollutants per mile--e.g. to and from work--than do "hot start" trips--e.g. home from the supermarket--see Figure VI-1. Therefore measures that reduce cold-start trips are particularly valuable.) The principal automotive pollutants of concern are carbon monoxide (CO), reactive hydrocarbons (HC) and oxides of nitrogen (NOx). The latter two combine in the presence of sunlight and high temperature to form photochemical ozone (smog). Particulates emitted from tire wear and tailpipes, and resuspended from roads by the wheels of motor vehicles, are also of concern.

The ability of a locality to implement these measures stems in large part from its regulatory powers over private land use, but can also involve projects or programs undertaken directly by the local government itself. Where a local action is discretionary in nature (e.g. a zoning change or conditional use), the necessity for mitigation measures can be based on the required environmental impact analysis and documentation.

The purpose of this chapter is to recommend air quality-related actions deemed appropriate in various situations, not to specify the precise form in which these actions should be framed by cities and counties. Local planners and municipal attorneys will have to determine the availability and feasibility of specific legal tools in each jurisdiction. However, the authors believe most, if not all, of the measures described here are within the realm of serious consideration by local governments.

Both land use and transportation are primary concerns in this chapter. However, the power of local government to affect land use is greater than its direct powers over transportation. While localities are the principal arbitrators of land use, their role in transportation decisions is often

secondary to other public and private agencies, including transit agencies (BART, AC Transit); regional transportation agencies (MTC); state transportation agencies (CALTRANS); non-profit organizations (RIDES); private and public employers; private and public fleet operations. For this reason, the chapter emphasizes those actions in which local governments can play a significant role. The authors recognize that some transportation measures, though important for air quality, are relatively neglected here; this simply reflects the fact that cities and counties play a minor role in implementing such measures. Nevertheless, even in these cases where a strong formal role does not exist, local planners and other officials can frequently function as informal advocates and can cooperate with transportation agency personnel to help implement appropriate actions. (See also: MTC's Traffic Mitigation Reference Guide.)

While this chapter is concerned with projects and plans within existing city and county jurisdictional limits and planning areas, the process of enlarging and altering these local boundaries (principally through annexation) is itself of great significance from an air quality standpoint. To the extent possible, the potential air quality impacts of major annexations, sphere of influence decisions, etc. should be assessed and appropriate response made. Although the arbiter of these actions is the Local Agency Formation Commission in each county (LAFCO) rather than individual local governments, the county planning department ordinarily staffs the LAFCO or has direct input into its deliberations. Within the framework of LAFCO's legal mandate, it should be possible to address air quality-related planning policy questions, e.g. growth rate limitation, jobs-housing balance, and compact/infill development questions.

Finally, there are instances when two or more local jurisdictions may find it necessary or desirable to coordinate their air quality mitigation and improvement efforts. Examples include county-wide growth and land use policies and inter-jurisdictional bicycle routes. In some cases "transportation corridor" planning in cooperation with ABAG, MTC and Caltrans may be appropriate.

B. Project Mitigation Measures for Air Quality

It should be noted at the outset that wherever possible, air quality quantitative analysis should precede consideration of mitigation measures. Such analysis can be done using the District's models and formulas or another suitable methodology. Furthermore, the mitigation measures themselves should be subjected to quantitative analysis where this is feasible. For example, where mitigation measures would reduce motor vehicle traffic, the air quality benefit vis-a-vis vehicle-generated contaminants is roughly proportional to the ratio between the volume of traffic eliminated and all expected project-related traffic--plus the possible additional benefit of reduced emissions from faster and smoother movement of the remaining vehicles on the impacted roads and intersections. (See the U.S. Dept. of Transportation and Ventura County documents cited in the Bibliography of these GUIDELINES and Table IX-F-1 for attempts to quantify mitigation measures in generalized fashion.)

Of course mitigation measures are actually beneficial only to the degree that they are implemented. Therefore it is important that the environ-

mental document candidly discuss the actual commitment that is being made by the appropriate agent, to the effectuation of each mitigation measure.

The recommendations in this section are contained in two tables and an explanatory text which follows the Tables.

Table IX-B-1 sets forth the main types of development project (across the top of the page) and the categories of mitigation measures (down the left hand side). These categories are grouped under four headings: Land Use Policies, Physical Facilities, Transportation-Related Management Actions and Siting/Design Requirements. By reading down each column, one can find the mitigation categories most appropriate for each type of project. Local planners can then evaluate these categories in detail for their suitability in a particular case, and can formulate specific mitigation measures within each category.

Table IX-B-2 relates the same mitigation categories to the three broad problem situations for which mitigation should be considered; these situations are defined at the bottom of the Table. By reading down the three columns, one can find the mitigation categories relevant to each air quality problem situation.

By using Tables IX-B-1 and IX-B-2 in conjunction, the planner can determine not only which kinds of mitigations to consider for a given type of project, but also how each kind of mitigation helps to alleviate a particular air pollution problem situation.

Following the tables, the text contains short descriptions of each mitigation category and its importance from an air quality standpoint, together with (in many cases) some specific mitigation measures for consideration. Bay Area examples are cited for some specific measures.

Users of the Tables should not take them as conclusive judgments of a measure's applicability or lack thereof in a particular case. The "x-marks" indicate those applications considered most likely by the authors, but other uses of the mitigation categories may be possible.

There are two kinds of mitigation measures which have general applicability and are not listed in the Tables: construction measures and project phasing.

Construction measures are aimed mainly at emissions of suspended particulates from project construction activities; such emissions can occur both on-site and off-site (from trucks going to and from the project). Although construction is a temporary activity, emissions can still be significant in some cases. Section IX-E contains a list of suggested measures to minimize dust pollutant from construction activities.

Project phasing may be utilized in any case where there is likely to be an adverse air quality problem, providing that the project is susceptible to development in stages. By matching the timing of actual development to the capacity of the road network, for example, it may be possible to avoid vehicle congestion, slow speeds and idling, and the resultant excessive pollutant emissions.

TABLE IX-B-1. AIR QUALITY MITIGATION MEASURES BY TYPE OF PROJECT

	LOW-DENSITY RESIDENTIAL	HIGH DENSITY RESIDENTIAL	COMMERCIAL/ INSTITUTIONAL	INDUSTRIAL
"Mixed Use"	x	x	x	
Alternate Land Use	x	x	x	x
Orientation to Transit		x	x	x
Special Use Conditions			x	
Bicycle and Pedestrian Facilities	x	x	x	x
Landscaping	x	x		
Transit Improve- ments and Amenities	x	x	x	x
Street Improve- ments		x	x	x
Ridesharing Incentives	x	x	x	x
Traffic Flow Improvement		x	x	x
Alternative Work Schedule			x	x
Transit Incentives			x	x
Site Plan Changes	x	x	x	x
Building Redesign	x	x		
Parking Redesign			x	x
Buffer Strip	x	x		x

TABLE IX-B-2. PROJECT MITIGATION MEASURES BY AIR QUALITY PROBLEM SITUATION

	SITUATION I	SITUATION II	SITUATION III
"Mixed Use"			x
Alternate Land Use	x	x	
Orientation to Transit			x
Special Use Conditions	x		
Bicycle and Pedestrian Facilities			x
Landscaping		x	
Transit Improvements & Amenities			x
Street Improvements	x		
Ridesharing Incentives			x
Traffic Flow Improvement	x		
Alternative Work Schedule			x
Transit Incentives			x
Site Plan Changes	x	x	x
Building Redesign	x	x	
Parking Redesign	x		
Buffer Strip	x	x	

KEY:

- I. Project causes air quality problem (exceeds standard, odor, toxic hazard).
- II. Project contains sensitive receptor which may be adversely impacted.
- III. Non-attainment sub-area; and project meets specified size and other local criteria.

Explanation to Table IX-B-2.

The basic idea behind this Table is that the type of mitigation measure considered should be responsive to the underlying situation which creates the need for mitigation. The three columns in the Table correspond to the three basic air quality situations where mitigation is appropriate:

1) The project can be shown to cause a localized air quality problem, exceedance of the CO standard usually due to mobile source emissions or an odor or toxic hazard from stationary source emissions. Under this situation the mitigation measures should bring about a direct and clearly demonstrable reduction or avoidance of the air quality problem.

EXAMPLES: - An industrial project will cause toxic hazard to nearby residents, as shown by an analysis of emissions and air quality modeling. Mitigation: substitution of an alternate use or alternative processes or control devices not causing toxic emissions.

- A shopping center will overload the adjacent traffic network, causing CO exceedances. Mitigation: Construction of a new access street to reduce traffic congestion and thereby avoid CO exceedances.

2) The project or nearby area contains a school, hospital, housing development or other sensitive receptor to be located in an area where air quality standards are likely to be exceeded or the residents/site users would be subject to unacceptable odor or toxic hazards. Under this situation the mitigation measures should again act directly to reduce or avoid the air quality problem.

EXAMPLES: - A convalescent home will be located in a area where the ozone standard is likely to be exceeded. Mitigation: Landscaping around the building can lower the intake of oxidants to the interior of the building.

- A school will be located on a large site which is marginally affected by odors from a sewage treatment plant. Mitigation: The school building could be sited in the farthest downwind portion of the site, basing the decision on existing or newly gathered meteorological data.

3) Regardless of whether or not the project also falls under Situation 1 or 2 above, the project will be located in a non-attainment sub-area or an area of high pollution-causing potential. Under this situation the mitigation measures should contribute directly or indirectly and in a cumulative sense toward resolution of the air quality problem.

EXAMPLES: - A large office complex will be built in a densely-built downtown area where CO excesses occur over a relatively wide area. Mitigation: Adoption of staggered work hours or a compressed work week can help reduce vehicle traffic

in the vicinity at peak hours, smooth out traffic flow, and

in the vicinity at peak hours, smooth out traffic flow, and thus reduce CO emissions and impacts in the downtown area.

- A large housing project will be built in an area whose emissions of ozone precursors contribute heavily to ozone exceedances in the Bay Area. Mitigation: Incorporation of convenience stores within the project to reduce the residents' need for vehicle travel and thereby reduce ozone precursor emissions.

Note: It is important to recognize that these three basic situations are not mutually exclusive. Thus, projects which create a specific air quality problem (Situation 1) will frequently also be in a non-attainment or high pollution-causing area (Situation 3) and therefore both sets of mitigation measures should be considered. It is also true that "sensitive receptor" projects (Situation 2) may fall under Situation 3, and in this case the Lead Agency may decide to combine such receptor-oriented projects with Situation 3 mitigation measures.

C. Description of Project Mitigation Measure Categories

1. Land Use Policies.

"Mixed Use." A large residential, commercial or office project may be deemed to generate excessive and unnecessary trips and vehicle miles traveled (VMT) if the residents, shoppers or employees have little alternative to use of the automobile for their daily functions. Due to the "cold start" phenomenon of vehicle pollution, a major objective for such a project should be to eliminate auto trips, not just shorten them.* Modification of the project to include a mixture of uses, together with proper site design, can reduce private vehicle trips in favor of walking, bicycling, or local shuttle.

Specific mitigation measures include:

- o Neighborhood shopping and other day-to-day personal services within a residential project, without additional parking for such service uses.
- o Major open space and recreational facilities within a residential project.
- o Provision of employee services within walking distance of employment, including banking, child care, eating and similar facilities.

*Most vehicle emissions from cold-start trips occur during engine warm-up and the first mile of travel; there are also substantial "hot soak" hydrocarbon emissions after trip completion. Thus trip length is becoming a relatively smaller factor in total trip emissions. (See Figure VI-B-1.)

TABLE IX-B-3. MITIGATION THRESHOLDS

Categories of Potentially Applicable Mitigation Measures,
According to Project or Plan Size Equalled or Exceeded.

Mitigation Measure Categories				
Land Use	Size Unit	Category A ¹	Category B ²	Category C ³
<u>Housing</u>				
Single Family	dwelling	200 units	600 units	1,000 units
Apartments	unit	300 units	1,100 units	1,800 units
<u>Parking</u>	parking space	250 spaces	1,000 spaces	1,700 spaces
<u>Shopping Center</u>				
Regional	1k ft ²	60,000 ft ²	200,000 ft ²	300,000 ft ²
Neighborhood	floor area	(or 6 acres	(or 20 acres)	(or 35 acres)
Individual Store	(acre of land area)	land area)		
<u>Industry</u>				
Undifferentiated	acre	15 acres	50 acres	80 acres
Mass Production	acre	15 acres	40 acres	70 acres
Industrial Park	acre			
Administration	acre	20 acres	65 acres	100 acres
Warehouse	acre			
Research & Devel.	acre	40 acres	130 acres	200 acres
<u>Office Building</u>	1k ft ²	100,000 ft ²	400,000 ft ²	700,000 ft ²
Gov't Offices	1k ft ²	30,000 ft ²	95,000 ft ²	150,000 ft ²
<u>Motel</u>	unit	200 units	700 units	--
<u>Restaurant</u>	seat	700 seats	--	--
Fast-food	employee	40 employees	--	--
Drive-in	1k ft ²	4,000 ft ²	--	--
<u>Theater</u>	seat	800 seats	2,800 seats	5,000 seats
<u>Any facility attracting or generating:</u>				
	motor vehicle trips per day (vehicles in and out)	2,000 trips (1,000 vehicles)	6,000 trips (3,000 vehicles)	10,000 trips (5,000 vehicles)
<u>Planning Actions</u>	acres affected	50 acres	150 acres	250 acres
Direct emission sources--e.g. industry; and transportation facilities--e.g. airports, ports, marinas, railroads.	sum of stationary and mobile source emissions	43 lbs/day HC or 550 lbs/day CO	150 lbs/day HC or 1,900 lbs/day CO	250 lbs/day HC or 3,000 lbs/day CO

1. Category A thresholds are identical to thresholds recommended for analysis of air quality impacts and submission to BAAQMD.
2. Projects equal to or larger than thresholds of Category B should also include appropriate mitigation measures in Category A. (Category B is based on levels of HC that would require BACT emitted from stationary sources.)
3. Projects in Category C should also include appropriate measures from Categories A and B. (Category C threshold is based on levels of HC that would require "offsets" or modeling if emitted from stationary sources, and CO equivalent if generated by motor vehicles.)

TABLE IX-B-4. SUGGESTED APPLICABILITY OF MITIGATION MEASURES

	<u>Situation 1</u> (local AQ problem)	<u>Situation 2</u> (sensitive receptor)	<u>Situation 3</u> (non-attainment area)
CATEGORY "A" PROJECTS (above review threshold)	Alternate Land Use (I) Special Use Conditions (C)(I) Traffic Flow Improvement Site Plan Changes Building Redesign Parking Redesign Buffer Strip (I)	Alternate Land Use Landscaping Site Plan Changes Building Redesign Buffer Strip	Orientation to Transit Bicycle/Pedestrian Facilities - dedicate bicycle lanes - bike storage facilities (C)(I) - sidewalks & curbs(R) - street design standards - intra-block walkways - pedestrian-emphasis Transit Improvement/Amenities - dedicate bus turnouts - transit amenities (shelters etc.) Ridesharing Incentives - reserved carpool parking (C) (I) Site Plan Changes - site design to promote transit - parking behind stores (C)
CATEGORY "B" PROJECTS (above NSR "BACT" level)	(ALL ABOVE MEASURES)	(ALL ABOVE MEASURES)	(ALL ABOVE MEASURES), PLUS: "Mixed Use" - open space & recreation (R) Bicycle/Pedestrian Facilities - shower & locker facilities (C)(I) Ridesharing Incentives (C)(I) - covered carpool parking - subsidy for employee carpools - employer-sponsored vanpools - employer ridesharing plan Transit Incentives (C)(I) - subsidy for employee fares - sales of transit tickets - free transit passes
CATEGORY "C" PROJECTS (above NSR "offset" level)	(ALL ABOVE MEASURES), PLUS: Street Improvements Site Plan Changes - varied building setbacks & heights for dispersion	(ALL ABOVE MEASURES)	(ALL ABOVE MEASURES), PLUS: "Mixed Use" - convenience stores (R) - employee services (C)(I) Transit Improvements/Amenities - subscription bus service (C)(I) - shuttle bus service - paratransit within project - new/relocated transit stop Ridesharing Incentives (C)(I) - on-site fuel for carpools - alternative work schedule Transit Incentives - new/expanded bus service - transit operation subsidy Site Plan Changes - varied building setbacks & heights for dispersion
<u>LEGEND</u> (R) = refers primarily to residential projects (C) = " " " commercial/ institutional " (I) = " " " industrial " See text for description of mitigation measures.			

NOTES

- 1) Criteria used in assigning mitigation measures to project size categories include estimated cost to developer of providing the mitigation measure; relative ease or difficulty (legal, administrative etc.) of actually implementing the measure; "feasibility threshold", i.e. some measures (vanpools, shuttle buses etc.) require a minimum project size or user demand, regardless of other considerations.
- 2) Many of the mitigation measures (transit amenities, carpool parking etc.) may be applied in greater or lesser degree based on size of the project and other factors.
- 3) In Situations 1 and 2, mitigation may be appropriate even for projects below the air quality problems which should be addressed directly on a case-by-case basis.
- 4) It is important to recognize that the three basic Situations are not mutually exclusive. Thus, projects which create a specific local air quality problem (Situation 1) or contain sensitive receptors (Situation 2) may also be located in a non-attainment or high pollution-causing area (Situation 3). For each project, all pertinent mitigation measures should be considered.

Alternate Land Use. Where a proposed project would cause a violation of air quality standards or emit noxious odors or toxic emissions, or would include sensitive receptors likely to be exposed to excessive pollution--and where other mitigation measures are not feasible or sufficient--the locality can seek to substitute an alternate land use which would avoid the air quality problem. Recent Bay Area examples of potentially incompatible projects include several housing developments proposed near industrial waste dumps, chemical plants, refineries, wastewater treatment plants, and other such industrial uses. In each case the BAAQMD recommended against the proposal to develop housing.

Orientation to Transit. A large project located near major transit facilities should be expected to support and enhance the transit option. To this end, the locality could require the developer to build to an appropriate density (not too low); to furnish land for transit support facilities; or to design the project for maximum transit access by foot (within one-quarter mile) or bicycle. An example is the Larkspur Landing Development, near the Golden Gate Ferry Terminal in Marin County, which includes medium-density commuter housing, offices, tourist-oriented shopping, and a pedestrian bridge over an arterial roadway connecting these uses to the Ferry Terminal.

Special Use Conditions. Certain auto-oriented uses have a high potential for causing localized air quality problems because they tend to create parking congestion, extended vehicle idling, and large concentrations of traffic within a limited area and a short time period. In these circumstances, high localized carbon monoxide (and lead) concentrations are possible. Such uses include "drive-in" restaurants and banks; enclosed parking garages; entertainment facilities; stadiums; airports. Through a special use permit procedure, a local government may impose conditions on these uses, e.g. criteria for location, size, layout, hours of operation, spacing of similar uses. Some jurisdictions in the Bay Area and elsewhere have sought to ban "drive-in" uses entirely.

2. Physical Facilities

Bicycle and Pedestrian Facilities. In appropriate situations, localities can require the provision of bicycle pathways and other bicycle- and pedestrian-related facilities. In order to create a meaningful alternative to automobile usage for short trips, bicycle paths should connect home-to-work or home-to-local shopping locations. To be most effective the paths should constitute a system linking a number of origins and destinations. A continuous pathway through a neighborhood can be implemented gradually as development occurs. In addition to the provision of pathways, bicycle travel can be encouraged through requirements for bicycle storage and other auxiliary facilities. Similarly, pedestrian pathways and other facilities can be required.

Specific mitigation measures include, for bicycles:

- o Required dedication of bicycle lanes through the subdivision ordinance.

- o Provision of secure, convenient indoor or outdoor bike storage racks by developers of shopping centers, office buildings and other places of employment. (e.g. Xerox in Stanford Industrial Park)
- o Provision of shower and locker facilities by employers, for employees who bicycle (or jog) to work. (e.g. Hewlett-Packard)

and for pedestrians:

- o Provision of adequate width sidewalks, with protective curbing, in new subdivisions.
- o Enforcement of street design standards, including landscaped strips between sidewalk and street, night lighting, safe islands in the center of major arterials, automatic or pedestrian-activated "Walk" signals, and adequate "Walk" times.
- o In center city redevelopment projects, emphasis on pedestrian circulation as well as limitations on automobile circulation.
- o Land uses that create pedestrian interest such as shopping and services in the first story of office buildings.

Landscaping. For residential and other sensitive receptor projects in high pollution areas, the locality can require special attention to the provision and design of landscaping. Vegetation can be effective in removing particulates and reducing oxidant levels near the point of receptor impact. (Landscaping is not effective in providing relief from high carbon monoxide levels.) Since the South Bay Area has both high particulate background and high oxidant levels, that area is especially appropriate for selective heavy landscaping treatment.

Transit Improvements and Amenities. Projects generating substantial auto trips and VMT in a non-attainment area could be required to provide or to finance physical facilities and equipment in support of transit ridership. Expensive transit improvements can be reasonably required only in very large projects, such as major redevelopment efforts. On the other hand, transit "amenities", while often low in cost and relatively easy to provide, are extremely important for increasing transit usage. In some cases, off-street parking requirements in local ordinances can be lowered in conjunction with the provision of transit improvements/amenities.

Specific mitigation measures include:

- o Employer-sponsored subscription buses ("club buses") to supplement or substitute for public transit service. (United Airlines, PG&E)
- o Provision of shuttle bus service from an employment center to main transit lines (Oakland's "Pill Hill", Alta Bates Hospital), or during lunch hours to provide employees with access to shopping and restaurants.
- o Required minibus, jitney or other para-transit service within a major subdivision, "New Town" development, university campus or other

large institution, or between several business/plant locations of the same employer.

- o Improvement and possible relocation of an existing transit stop or station to serve both new and existing surrounding development.
- o Required dedication of bus turnouts under the subdivision ordinance.
- o Required amenities to increase the convenience and attractiveness of transit stops, i.e. passenger staging areas, waiting shelters, benches, windcreens, landscaping, telephones, drinking fountains, etc.

Street Improvements. If a project air quality analysis shows violation of an ambient air quality standard (usually carbon monoxide) due to the project, an effective--though sometimes expensive--way to mitigate the impact may be to widen or otherwise improve the intersection or bottleneck causing the violation, or even to build a bypass roadway around it. The developer can be made to bear or to contribute to the cost of the improvement. This action can reduce localized emissions by removing congestion and speeding traffic. However, a traffic and CO analysis is necessary to predict whether the improvement is likely to be effective. In performing the analysis, care must be taken to balance the predicted reduction in congestion against the possible increase in "induced" traffic.

3. Transportation Related Management Actions

Ridership Incentives. Where deemed appropriate (in a non-attainment area) because of project size, inadequacy of transit, or other local criteria, the locality can require a commitment from the developer to one or more ridersharing (car and van pooling) measures. Where such commitment is required as a condition of project approval, the question of how the commitment will be monitored and enforced is a crucial one.

Specific mitigation measures include:

- o Require an employer/developer to reserve a percentage of off-street parking spaces for car/van pool vehicles, with discounted rates if a charge is made. (U.C. Berkeley, Children's Hospital in San Francisco)
- o Employer provision of covered or more conveniently located parking for car and van pool vehicle.
- o Employer subsidy to employees using car and van pools. (Syntex in Palo Alto)
- o Employer transportation subsidy to all employees, possibly strengthened with a commitment to charge parking fees for single occupant vehicles.
- o Employer sponsored and organized van pools. (Fireman's Fund)

- o Provision of fuel on-site to car and van pool vehicles, with possible priority allocation during fuel shortages. (ROHM in Santa Clara)
- o Employer commitment to promote ridesharing through various educational and training media (could also include promotion of transit, bicycling and walking to work). This commitment and the preceding measures will be most effective if a definite trip-reduction target is set, a plan to reduce single-occupant vehicle travel is developed and approved by the locality, and a full- or part-time transportation coordinator is designated by the employer.

Traffic Flow Improvement. Where auto traffic resulting from a project is projected to cause a violation of the carbon monoxide standard or other air quality problem, the effects may be mitigated through the use of techniques to smooth and speed traffic flow, resulting in reduced emissions. While these actions are generally carried out by the local public works department, the developer may be assessed pro rata for their cost (which should usually be low compared to capital-intensive construction such as a major street widening). The projected effectiveness of these measures should be based on a CO analysis, in which the likelihood and extent of additional "induced" traffic should be evaluated.

Specific mitigation measures include:

- o Provision of demand-responsive traffic signals, with signal splits and phase lengths automatically adjusted to traffic demand on a real-time basis.
- o Intersection re-channelization.
- o Minor intersection reconstruction to eliminate jogs and offsets which produce signal timing problems.
- o Correction of minor physical deficiencies of existing roads, such as inadequate lane widths, surfaces, drainage, etc.
- o Prohibition of on-street parking on selected streets affected by project traffic.

Alternative Work Schedule. Where project size and other specified local criteria are met, staggered work hours, compressed work week or other alternative scheduling devices can be considered as mitigation measures. This kind of measure is especially appropriate where commute hours are congested and transit is overcrowded. Flexibility in starting and quitting times results in stretching out the commute period, thereby alleviating congestion, increasing vehicle speeds and reducing emissions. However, care should be taken to avoid too much individual flexibility, which can make ridesharing more difficult. Compressed work week (which actually reduces total work trips) has an especially high potential for emission reduction. A different kind of alternative, which may hold promise for computer-oriented business, could involve part of the work force working at home and using telecommunications to "interface" with the workplace, thereby reducing traffic on the road.

In downtown San Francisco, the Metropolitan Life Insurance Company has pioneered in the adoption of alternative work schedules, and other large "information industry" corporations have actively promoted these measures. Requirements for individual firms in large employment centers (industrial parks, office parks) should be coordinated, especially those with a limited number of ingress and egress points. Monitoring and enforcement of conditions in this mitigation category will demand particular attention.

Transit Incentives. Where projected auto emissions are deemed to warrant mitigation and transit is available, the developer may be required to sponsor measures to increase the use of transit by employees, customers or residents. In some cases, off-street parking requirements in local ordinances might be lowered in conjunction with such employer transit incentives. Buses, boats, and some other transit vehicles are not pollutant-free; but there is generally much lower emissions per person served than would be the case with private autos.

Specific mitigation measures include:

- o Transit agency agreement (with developer support and as part of the development approval process) to reduce headways on high-demand routes and thereby reduce high-load factors caused by the proposed project.
- o Transit agency agreement (with developer support and as part of the development process) to institute new routes or express bus service, or to expand existing routes or service, related to the demand caused by the proposed project.
- o Require employer subsidy payments for transit operation costs.
- o Employer/developer subsidizes employee transit costs in whole or in part. (Shugart in Palo Alto)
- o Employer/developer agrees to provide transit tickets through payroll deductions or over the counter.
- o Retail facility developer provides for free transit passes to be given away to shoppers by merchant/tenants.

4. Siting/Design Requirements

Site Plan Changes. Such changes can serve several functions, depending on the air quality problem involved: re-siting of buildings, roads and other project features to promote better traffic flow within the project and thereby reduce pollutant emissions; redesign of building relationships to help disperse pollutants; relocation of sensitive receptors to avoid harmful exposure to pollutants; or redesign for improved transit access, bicycle or pedestrian use.

Specific mitigation measures include:

- o Design of new developments to promote the use of public transit, e.g. streets with bus turnouts, avoidance of long cul-de-sacs, streets of sufficient design to handle buses.
- o Placement of new commercial establishments to front directly on the sidewalk with parking in the rear, for easier transit and pedestrian access.

Building Redesign. Layout, entrances and exits of parking facilities may need redesign to avoid violations of air quality standards, especially for uses with concentrated traffic patterns such as parking garages, major employers, shopping centers, amusement and sports facilities.

Specific mitigation measures include:

- o Require design of parking structures and ramps to provide adequate off-street storage for entering vehicles to minimize on-street congestion and to avoid internal back-up and idling of vehicles.
- o Require design of parking facilities so they can be converted to other uses if values and habits change in the future.
- o Reduce number of off-street parking spaces provided (should be combined with mandatory measures to reduce single-occupant vehicle usage through improved transit, ridesharing or otherwise.)

Buffer Strip. This is a special case of a site plan change. It may be applied either to an industrial project near housing or other sensitive receptors, or to a residential project adjoining a heavily traveled road. In either case, the objective is to leave an open buffer strip between the pollution source and the receptors, so that gaseous or particulate emissions will be reduced by dispersion before reaching the receptor areas. The buffer strip itself may be retained in private ownership but restricted from development, or it may be dedicated to a public entity. The presence of natural or introduced vegetation can in some cases strengthen the buffering effect. (In any case where a buffer strip is being considered, especially in relation to industrial emissions, the BAAQMD should be contacted for review of the necessary width and potential effectiveness of the buffer.)

D. Non-Project Air Quality Improvement Measures

1. Introduction

The recommendations in this Section are contained in Table IX-D-1 in the explanatory text.

Table IX-D-1 shows the four major divisions of air quality improvement measures (across the top) and on the left hand side indicates the major local planning functions pertinent to air quality improvement.

General Plans includes the preparation of a new or revised General Plan for the community, either in complete form or comprising one or more mandatory or optional "Elements" under state law.

Development Ordinances includes zoning, subdivision and other local "police power" ordinances (or ordinance amendments) used to control physical development in the interests of public health, safety and welfare. Such ordinances often implement particular General Plan policies.

Area Plans and Programs includes comprehensive and fairly detailed development plans covering a limited section of the community, e.g. a primarily residential neighborhood, a downtown area, or a balanced "New Community." Such plans may have formal status under state law as Specific Plans or Redevelopment Plans; or they may be intended to provide less formal guidance to developers and public agencies.

Transportation Programs includes a variety of policies, facilities, actions and requirements which can be undertaken or supported by local governments. The scope of these programs may either be community-wide in scope or confined to one or more neighborhoods or sub-areas.

Table IX-D-1 may most usefully be read in a horizontal direction, to determine which kinds of the air quality improvement measures are most appropriate when a locality is doing a General Plan revision, for example.

The text following Table IX-D-1 contains a short description of each air quality improvement measure or category of measures and its significance. Bay Area and other examples are in some cases cited for informational purposes. Note that in certain instances what appears to be a General Plan amendment, zoning ordinance change, local area program, annexation or other "non-project" action is really for practical purposes a specific development project. In such cases it may be appropriate to deal with the proposal by applying project mitigation measures (Sections IX-B and IX-C) as early as possible in the local review process.

Even when a "non-project" action is more general in nature, there are often close relationships between non-project air quality improvement measures and project mitigation measures as described in Section IX-C of this

TABLE IX-D-1. NON-PROJECT AIR QUALITY IMPROVEMENT MEASURES BY LOCAL PLANNING FUNCTION

	LAND USE POLICIES	PHYSICAL FACILITIES	TRANSPORTATION-RELATED MANAGEMENT ACTIONS	SITING AND DESIGN REQUIREMENTS
GENERAL PLANS	Growth rate limits Jobs-Housing balance Compact/infill devel. Land use-transit coord. Mixed land uses.	Balanced transportation system Bikeway system Utilities extension plan	Parking policies Transit service policies	Sensitive receptor location policy Buffer area policy
DEVELOPMENT ORDINANCES	Zoning map and text provisions Growth management zoning Special use permit requirement	Subdivision ordinance dedications Bicycle storage racks	Parking regulations Street closing ordinance Ridesharing ordinance	Special use permit criteria Zoning for buffers and setbacks Subdivision ordinance standards
AREA PLANS & PROGRAMS	Land use--transit coord. Mixed land uses Phased development	Special transit system Area bikeway plan Pedestrian mall	Area parking permit Auto free or limited zone	Buffer areas and sensitive receptors
TRANSPORTATION PROGRAMS	Transit--land use coordination	Transit extensions Transit amenities Bus/Carpool lanes Park and Ride lots Transit terminal	Transit and ridesharing incentive programs Traffic flow improvement Flexible working hours Pricing actions	Excess condemnation

Guide. For example, the categories "Ridesharing ordinance" and "Transit and ridesharing incentive programs" in Table IX-D-1 correspond to "Ridersharing Incentives" and "Transit Incentives" in Tables IX-B-1 and IX-B-2. Moreover, certain measures or categories are found across a spectrum of levels from General Plans to Development Ordinances to Area Plans or Transportation Programs to project mitigation measures; examples include mixed land uses and bicycle facilities. On the other hand, some non-project categories such as growth rate limitations, area parking permit and pricing actions have no counterpart at the project mitigation level.

The listing and description here of various kinds of air quality improvement measures does not imply that all these measures can or should be implemented in every locality. Obviously conditions will vary widely and this variation will influence the local choice of measures to be considered. Nor does this listing exclude the adoption of measures not listed, where there is reason to believe such measures will lead to better air quality. However, in the judgment of the BAAQMD's Planning Division, the measures listed here are those most likely to contribute to significant air quality improvement. Wherever possible, quantitative analysis should precede or accompany consideration of air quality improvement measures. (See the U.S. Dept. of Transportation and Ventura County documents cited under Bibliography and Table IX-F-1 for examples of such quantification.) At the same time, we must recognize that the air quality effects of non-project measures are often long-range, and difficult to quantify. This does not diminish the importance of these measures, particularly in view of their frequently "synergistic" nature, i.e. separate measures relating to land use, transit, ridesharing, bicycling, etc. often tend to reinforce and magnify one another's impact.

Finally there are two general measures not covered in Table IX-D-1. First, if a locality is interested in making a serious effort to incorporate air quality into its planning functions, consideration should be given to the preparation of an Air Quality Element of the General Plan. Though not required by state law, the preparation of such an element can help bring relevant air quality data to bear during the community's basic planning process, and will influence many of the other General Plan Elements. (In the Bay Area, Sonoma County has prepared an Air Quality Element.) However, it is not necessary to prepare a separate element in order to incorporate air quality considerations into the required (and optional) elements of the General Plan; many aspects of air quality improvement can be incorporated into Land Use, Circulation, Conservation and/or other plan elements.

Second, the preparation of an Area Plan which includes explicit air quality analysis can itself serve as an air quality improvement measure. This is most appropriate where a number of developments are taking place in a specific sub-area of the locality. The Area Plan provides an overall perspective within which the cumulative air quality impact as well as that of each individual project can be evaluated. This approach is currently being considered by the City of Oakland.

2. Description of Non-Project Improvement Measures

GENERAL PLANS

LAND USE POLICIES

Growth rate limitations: An effective local air quality strategy could involve a General Plan policy to limit the rate of growth in the locality. This would bring about a generally proportionate decrease in the number of mobile sources, emissions of auto-related pollutants, and ambient concentrations of localized pollutants. Petaluma, Napa and Livermore are examples of cities where growth rate limits have been utilized. For local planning within the context of regional air quality planning, an appropriate objective would be to stay within the population and employment figures used as the basis for the 1982 Air Quality Plan update.

Jobs-Housing balance: To reduce automobile-generated air pollution in the community as a whole, the General Plan should relate jobs and housing in terms of numbers and types of jobs vis-a-vis housing units appropriate to workers. The need for this is underscored for example in northern Santa Clara County, where there is a scarcity of housing in relation to employment (in the Livermore Valley the situation is reversed but may come to resemble the Silicon Valley if jobs grow faster than housing opportunity). For specific sub-areas, job-housing balance could mean controlling the location as well as the intensity and nature of jobs and housing in order to minimize vehicle trips and VMT, and maximize transit usage, bicycling and walking. For example, plan policies can favor the location of relatively high-density housing near employment centers, with housing units appropriate to the workers in those centers.

Compact/infill development: The General Plan should promote concentrated residential, commercial and industrial centers, close-in and contiguous to urban core areas. Infill of underdeveloped and bypassed areas should be encouraged; scattered and leapfrog development should be discouraged. An urban limit line can reinforce these policies. On a regional basis, adoption of a compact development strategy could reduce emissions 11% by the year 2000.

Sonoma County and Santa Clara County have adopted a form of compact/infill policy in their General Plans. A caveat here is the possibility of localized congestion and adverse air pollution impact as a result of policies to concentrate an intense amount of development; this question deserves analysis and may itself require a mitigation strategy.

Land use-transit coordination: Plan policies should promote optimal relationship of trip origins and designations (i.e. land uses) to transit routes and stations, in terms of proximity, density of development and means of access. Examples would be policies favoring high-density housing as well as high-intensity employment in the vicinity of BART stations and along well-served transit corridors.

Mixed land uses: The General Plan should further the concept of complementary mixed uses (ordinarily residential and commercial), within a

single development project, in order to reduce vehicle trips and VMT. For example, a sizable residential project can include neighborhood shopping services. To the extent possible, a major objective is to eliminate private vehicle trips, not just shorten them; the project should be planned for maximum use of walking, bicycling and local transit to serve internal travel needs.

In other words, there is need to strive for optimum density and land use mix; dense enough to encourage transit and minimize journey-to-work; not so overly dense to cause local carbon monoxide hotspots.

PHYSICAL FACILITIES

Balanced transportation system: The General Plan should support public transportation alternatives not only through land use policies regarding location, densities, etc., but also directly through the planning and programming of a balanced transportation system. Such a system includes transit routes and vehicles, terminals, and bicycle paths, as well as necessary streets. The nature and extent of non-automotive transportation planning will of course vary depending on the type of community involved--whether highly urbanized or suburban, large or small--but should be the maximum possible in the circumstances. The Marin County Balanced Transportation Plan provides a good example.

Bicycle circulation system: While recreational bicycle paths are highly desirable, from an air quality standpoint the emphasis in bicycle planning should be on commuting and shopping trips because these provide the greatest potential for reduction of automobile travel. The General Plan objective should be to create a bicycle circulation system linking homes, offices, commercial areas and public facilities. The plan for a bicycle circulation system will normally include locational criteria and design standards; and may include a Plan Map showing the generalized location of proposed pathways. Localities which have successfully planned for bicycle travel include Davis, Sacramento and, in the Bay Area, Palo Alto and Livermore. In addition to bicycle paths, the plan can also contain policies promoting supporting facilities like bicycle storage racks at key destination points.

Utilities extension plan: The location and sizing of water and sewer systems can be planned in conformance with air quality-related local growth policies. Similarly, utilities planning can be related to the population and employment figures used in projecting future air quality for regional air quality planning purposes. In this way the major infrastructure of growth can be made consistent with policies favoring improved future air quality in the community and region. An example of sub-regional utilities planning in accordance with air quality goals is the sewage treatment facilities planning and capacity allocation carried out by the Livermore-Amador Valley Wastewater Management Agency.

TRANSPORTATION-RELATED MANAGEMENT ACTIONS

Parking policies: At the General Plan level, parking policies can address the extent to which parking "demand" should be accommodated in private developments, especially where adequate transit service exists in the area. Provision of over-abundant parking can counteract policies to minimize auto use. Parking policies can also deal with the location of parking facilities

in relation to high-density activity centers, e.g. downtown San Francisco. Parking policies for joint use of parking facilities and other more detailed matters may also be adopted.

Transit service policies: Even where the local government is not itself a transit provider, its General Plan should if possible contain transit service policies which can influence the responsible transit agencies. Among the questions which can be addressed are the provision of service to planned high-intensity land uses, criteria for the establishment of routes in terms of maximum distance from homes and businesses, desirable frequencies of service, and coordination between local and regional transit systems.

SITING/DESIGN REQUIREMENTS

Sensitive receptor location policy: Sensitive receptors are those facilities most likely to be used by the elderly, children, the infirm, or persons with particular sensitivity to air pollutants. The category includes hospitals, nursing and convalescent homes, schools, parks, playgrounds, senior citizens' housing and family-oriented housing. The principal policy concerns are to minimize the localized impact of carbon monoxide and lead from highway traffic; and to avoid or minimize the impact of industrial sources on potential nearby receptors. Adverse industrial impacts may relate not only to the so-called criteria pollutants (those for which standards have been established), but also to nuisances and hazards such as odors and toxic emissions which may occur during regular operations or during upset/breakdown conditions.

Buffer area policy: The buffer area approach complements sensitive receptor location policy by focusing on the physical areas separating such receptors from pollution sources. Buffers are mapped or otherwise spatially defined strips or large areas, specified either in advance of development or in response to a development proposal. Being kept free of development, these buffers allow for dispersion of gaseous and particulate emissions before they reach sensitive receptors or inhabited areas. Examples are a buffer strip along a highway and a buffer area surrounding an industrial project. The General Plan can include criteria for the depth and size of buffers, especially for highways. For instance a 100-200 foot separation between road and receptor could have a significant effect on CO levels at the latter. However, decisions on the specifics of industrial buffer areas often require a case-by-case or, at least, type-by-type approach.

3. Development Ordinances

LAND USE POLICIES

Zoning map and text provisions: The General Plan should set forth land use policies to improve air quality, but implementation of these policies usually depends on changes in the zoning ordinance. In order to achieve jobs-housing balance, compact/infill development, land use-transit coordination and mixed land uses, the zoning map and text can spell out necessary requirements in more precise and enforceable form than the General Plan. The variety of implementing techniques can only be touched on here. Mapping techniques include the use of overlay zones, special zones, and small discrete zoning districts rather than large areas of homogeneous zoning. Text

provisions can relate to permitted land uses, prescribed densities (minimum as well as maximum), special use conditions, and mixture of land uses within a zone.

Growth management zoning: Two ways to implement a growth rate limitation policy are growth sequence zoning and an annual development quota. Growth sequence zoning can be used to control the timing and location of the community's growth so as to reduce future auto travel and pollutant generation. In general, it involves the staging of growth in different locations, subject to spatially varying conditions, and tied to the availability of public services prior to development. Localities can also use this type of zoning (the "Ramapo approach") to carry out land use policies promoting compact/infill development and land use-transit coordination.

An annual development quota may provide a numerical or percentage growth limitation in terms of new dwelling units, jobs or population. This technique requires an administrative mechanism to assure efficiency and equity, e.g. a review board and a point system to "score" potential developments. Petaluma is the well-known prototype here.

Special use permit requirement: As indicated in the Project Mitigation section, certain land uses, such as "drive-in" food and banking establishments, have a high localized air pollution potential. These may be listed in the zoning ordinance as conditional or "special permit" uses to be evaluated on a case-by-case basis as individual developments are proposed. Criteria for location, layout, etc. to protect air quality can be written into the ordinance. In such situations, follow-up monitoring and enforcement should be anticipated. Alternatively, a locality may attempt to prohibit "drive-in" uses completely within the community, e.g. Saratoga.

PHYSICAL FACILITIES

Subdivision ordinance dedications: Pursuant to state law, localities can require dedication of land (and perhaps in-lieu contributions) in their local subdivision ordinances for bicycle pathways, pedestrian ways and transit-related facilities to promote reduced auto usage.

Parking requirements: Off-street parking regulations can be adopted as part of the zoning ordinance or as a separate ordinance. In specifying the required amounts of off-street parking for private and public developments, the locality should attempt to reduce these amounts where nearby transit service is available and adequate. Other areas where parking policies for air quality improvement can be implemented through local regulations include: the location of parking lots and garages; joint use of parking facilities; regulation of parking rates to discourage vehicle usage; and restriction of on-street parking at congested locations and during peak traffic hours. San Francisco with its C-3 zoning regulations is a notable example of the implementation of parking policies. Sacramento and Portland, Oregon have made significant efforts to use parking limitations and location as an air quality tool.

Street closing ordinance: Such ordinances can be used to implement changes in vehicular and pedestrian circulation to improve localized air quality (and to achieve other goals of the community). For example, a

downtown auto-free zone or pedestrian mall often requires street closings to become effective. Traffic diverters can channel traffic--and pollutants--away from some streets, though caution is required lest traffic and air quality conditions deteriorate too much on the streets to which autos are diverted. This subject is closely governed by state law, which should be consulted.

"Ridesharing" ordinance: This is a new type of ordinance adopted by some localities. The ordinance can require assurance from developers and employers to implement measures to promote and support ridesharing (car and van pools) and reduce vehicle travel, e.g. provision of information and services; assignment of a transportation coordinator; preferential parking for rideshare vehicles; sponsorship and support of a van system; and so on. The ordinance should provide for the setting of a trip-reduction target and should require each affected developer or employer to prepare a plan showing how the ridesharing program will be implemented; this plan would then be reviewed and accepted by the locality.

Criteria should be spelled out for: when such measures will be required; which measures will be required under what circumstances; what incentives (if any) will be afforded; how implementation responsibilities will be transferred from developers to property owners and to employer-occupants; how the measures are to be reviewed and approved; and how monitoring and enforcement will be carried out. Denver and localities in South Placer County (near Sacramento) have pioneered this approach. Pleasanton is a local example.

SITING/DESIGN REQUIREMENTS

Special use permit criteria: Among the zoning ordinance criteria that may apply to conditional use or special use permits, some relate primarily to questions of siting and design. For example, sensitive receptors may be subject to substantial setbacks from streets and other pollution sources; industries may be required to locate pollution sources on their property so as to reduce the exposure of adjacent land uses. (See also discussion above under "Special Use Permit Requirement.")

Zoning for buffers and setbacks: Aside from special use permits, the zoning process may employ a number of techniques to implement siting and design policies aimed at protecting the public from excessive exposure to air pollution at a localized scale. These include detailed and careful mapping of basic use zones; use of overlay zones; setback ordinances; and flexible control through the use of "clustering" and other Planned Unit Development procedures.

Subdivision ordinance standards: Improvement and design standards for streets are normal parts of a local subdivision ordinance. Localities can write such standards so they will be supportive of transit usage and non-motorized travel. Examples include mandatory provision of bus turnouts on busy streets; avoidance of long cul-de-sac treatment; construction of streets strong enough to support buses; street design standards favoring bicycle and pedestrian usage, as well as intra-block requirements for bikeways and pedestrian paths. (Such standards are separate from dedication requirements, discussed above.)

4. Area Plans and Programs

LAND USE POLICIES

Land use-transit coordination: While the General Plan is concerned with community-wide policies, an area plan indicates specific land uses on a local or neighborhood scale and locates them on a map. An area plan may take the form of a Specific Plan or a Redevelopment Plan under the state law. Since they are definite in nature, the land uses, densities and other features of the plan can be coordinated closely with nearby transit facilities. An example would be the inclusion of a special transit way in a Redevelopment area, with land uses oriented to convenient transit access points.

Mixed land uses: The mixed use concept involves "complementary" uses, and the more specific the level of planning the better one can judge just how complementary--i.e. traffic-reducing--the proposed uses will in fact be. An area plan is intermediate in specificity between a General Plan and a project plan. Therefore, the description and mapping of mixed-use areas in an area plan should go beyond the policy level to specify the uses involved in terms of building type, density range, etc. On the other hand, an area plan would probably not contain a precise site plan, exact densities, price/rent levels and other such details usually found in a project plan.

Phased development: In rapidly growing areas of the community, phasing of development can be an important consideration in minimizing pollution. For example, development can be staged to match the capacity of the road network at any given time. In this way vehicular congestion--and excessive pollutant emissions produced by congestion--can be reduced. Such an approach has been taken in the Evergreen area of San Jose. The ability to phase an area plan for air quality purposes depends in part on how the plan will be implemented. Where a single agency or developer controls the land, as in the case of a Redevelopment Plan and some Specific Plans, there is a greater ability to phase development successfully.

PHYSICAL FACILITIES

Special transit systems: As part of an area plan, special transit facilities such as shuttle bus, paratransit or a "people-mover" may be included. Such a system could serve local circulation needs within a downtown or other concentrated area, or could supplement the regional transit system, e.g. a shuttle bus to BART. In a very large project the developer rather than the public could be expected to provide the special transit system. An example of a special transit facility is the UC shuttle to the Lawrence Berkeley Laboratory.

Area bikeway plan: At the area planning level, bicycle planning should be specific as to the location and characteristics of the system. Key destinations should be connected, there should be clear linkages to the community-wide system, and if possible, implementation should be provided through developer commitment, redevelopment funding or other means. Also, at the detailed level of bicycle planning it should be noted that separated bike paths are not always financially or physically feasible. However, care must be exercised to avoid placing a bike path next to a freeway or heavily traveled arterial for a substantial distance (in the absence of an intervening buffer

strip) since exposure to high carbon monoxide concentrations reduces the blood's ability to carry oxygen at the same time that exercise is increasing the body's oxygen demand.

Pedestrian mall: A mall is sometimes proposed for the downtown retail core. By closing (or partially closing) one or more streets, auto traffic is reduced or eliminated in a particular area, and thus exposure of shoppers and other pedestrians to high pollution levels (carbon monoxide) is minimized. Since large numbers of people are often involved, a mall can be an effective tool for better air quality, even if automobiles are excluded only during heavy pedestrian-use hours. A successful mall requires public expenditures for special paving, lighting, street furniture, landscaping, etc. In California cities, examples with varying degrees of success include Maiden Lane and other alleys in San Francisco, Napa, Santa Cruz, Sacramento and Fresno.

TRANSPORTATION-RELATED MANAGEMENT ACTIONS

Area parking permit: Measures of this type are intended to protect neighborhood residents from inundation of their streets and parking spaces by commuters, shoppers and other visitors who find it convenient to park in the neighborhood while using urban commercial facilities. In San Francisco, for example, local residents in some areas are issued stickers which entitle them to park on the streets at any time, whereas non-residents can park for limited periods only. Besides protecting impacted neighborhoods from overuse, such measures promote air quality by reducing the amount of slow-moving, block-circling traffic hunting for parking spaces; such traffic movement is highly polluting in a local area. An area parking permit program also helps reduce the number of people who bring cars into the city and encourages use of transit instead.

Auto-free/limited zone: The creation of an auto-restricted zone in an urban core area can reduce the impact of air pollutants, especially carbon monoxide, on pedestrians. To be successful, such a zone should usually be integrated with peripheral parking as well as local transit service. Enhancing the attractiveness of a central area for shoppers and other pedestrians can also reduce total trips and VMT because people will choose to come downtown--often using transit--rather than driving to scattered suburban locations. Construction of a pedestrian mall can further enhance the appeal of an auto-restricted zone. Before embarking on action of this kind, an analysis of existing and expected pollutant levels in the local area--and in the streets or areas to which traffic may be diverted--should be performed. San Jose is planning for possible elimination of private automobiles from some streets in their downtown Redevelopment program.

SITING/DESIGN REQUIREMENTS

Buffer areas and sensitive receptors: The treatment of buffer areas will vary in specificity as one moves from the General Plan to the project level. Here again, the area plan is intermediate in nature. It should be possible to go beyond policy statements to describe and map buffer areas and strips based on land uses in the area plan; however the precise width and shape of these buffers may have to await specific project proposals. Similar considerations apply to the treatment of sensitive receptors at the area plan level.

5. Transportation Programs

LAND USE POLICIES

Transit-land use coordination: Just as land use planning should be coordinated with existing and planned transit facilities, so the provision of transit should be closely linked to the location and trip-generating character of local land uses. This principle, fundamental to transit planning, is basically a matter of matching supply of transit to demand and maximizing the efficiency of the transit system. Local government policies should provide for keeping transit agencies fully informed of current land use data and anticipated future developments, in order to serve air quality as well as other community goals.

PHYSICAL FACILITIES

Transit extensions: Local governments, unless they own and manage the local transit system, have no direct responsibility for extending transit services and facilities. Where they do run their own system (e.g. San Francisco Muni, Santa Clara County) they are directly involved in transit planning as well as necessary funding for new extensions. In other cases, such as A.C. Transit and Golden Gate Bridge District service areas, the local government role, though limited, can be useful in encouraging and persuading transit agencies to consider transit extensions based on land use studies and plans.

Transit amenities: This term is used to signify auxiliary passenger facilities which assist and encourage transit usage. Examples include passenger staging areas, waiting shelters, benches, windscreens, landscaping, telephones, drinking fountains, etc. Such facilities are relatively low in cost and easy to provide, but important for increasing the attractiveness of transit to the public and thereby reducing vehicular pollution. Many of these amenities can be provided either by public agencies (transit agencies or local governments) or by private developers and employers--often as project mitigation measures.

Bus/carpool lanes: The idea behind an exclusive bus/carpool lane is to increase the average speed of multiple-occupancy vehicles and therefore their relative attractiveness to the public. By getting people out of their single-occupancy cars, total trips, VMT and emissions should be reduced. The planning and construction of a new bus/carpool lane is usually the charge of the State Department of Transportation (CALTRANS). However, a locality can be influential in supporting and speeding the completion of such a project. For example, Marin County has included a major bus/carpool lane extension as a key element of its General Plan update and has actively worked with CALTRANS to implement the proposal.

Park and ride lots: In low-density suburban areas where it is impractical to use transit for the first leg of a journey, parking lots along transit routes and at stations (e.g. BART stations) can increase transit usage and reduce VMT. Note however that since these lots and the surrounding streets can often be congested at peak hours, design and layout should be carefully considered to reduce possible localized carbon monoxide impact. Park and ride

lots should include protected bicycle lockers. Where it is feasible to implement local bus shuttle service to main-line transit routes, this should take precedence over park and ride lot construction from an air quality standpoint, because the elimination of auto use entirely for a trip is generally more important than reducing the length of that trip.

Transit terminal: The provision of multi-modal transportation centers, generally in downtown areas, can enhance transit use by making transfers easier and providing amenities such as food and drink, comfortable waiting areas, and personal services. The Trans-Bay Terminal in San Francisco is an example.

TRANSPORTATION-RELATED MANAGEMENT ACTIONS

Transit and ridesharing incentive programs: A city or county may choose to undertake a concerted program to promote transit usage and/or ridesharing. This program can be implemented by the locality directly, or through a non-profit corporation such as RIDES, or through major employers. The objective is to decrease private vehicle trips, VMT, localized congestion, and consequent vehicle emissions. Such a program could well start with the locality's own employees. For specific measures which could be included, see the Project Mitigation section of this chapter, under "Ridesharing Incentives" and "Transit Incentives."

Traffic flow improvements: This general category includes a variety of techniques to speed flow on existing roadways and thereby reduce localized carbon monoxide and other pollutant concentrations. (Note however that these beneficial effects may be counteracted by additional induced traffic.) Besides the measures specified above in the Project Mitigation section, techniques may include designation of exclusive or preferential bus/carpool lanes on existing roadways (without new construction); ramp metering, with or without preference for multiple-occupancy vehicles; and prohibition of on-street parking at congested times and places. "Preferential" techniques serve to enhance the relative attractiveness of transit and ridesharing modes, and therefore in theory should improve associated auto traffic flow, but they require careful monitoring to confirm their effectiveness in practice. Ramp metering also requires monitoring because of potential diversion of traffic congestion onto local streets.

Flexible working hours: Staggered work hours, compressed work week and other scheduling alternatives may be used as project mitigation measures, but they should be seen primarily as community-wide or local sub-area efforts to reduce auto congestion. A local government program can encourage and facilitate coordinated action on flexible work hours by public and private employers generally or within a given area, e.g. a downtown or industrial park. While flexible hours can serve to enhance transit viability where transit is overcrowded during normal rush hours, in other situations such alternatives could adversely affect the scheduling and viability of the transit system.

Each employer must evaluate the feasibility of a flexible scheduling alternative with respect to its own internal operations and requirements. The concept is sometimes implemented in terms of "window" of starting and quitting time, i.e. an employee can start work anytime between 6 and 9 a.m. and leave work accordingly. (However, too much discretion given to each individual

employee can impair the feasibility of ridesharing efforts.) The compressed work week alternative (4 days, extended hours each day) reduces total work trips and VMT as well as congestion, and thus has a beneficial regional as well as local air quality effect. This technique has great potential effectiveness.

Pricing actions: In some cases, local governments are in a position to control or at least to influence pricing actions. Transit fares can be reduced (or even eliminated) in order to increase transit usage. The "Shoppers Shuttle" in some downtown areas is an example. Conversely, the cost of off-street parking and the level of highway tolls can be raised in order to discourage automobile usage. While pricing actions are complex and multifaceted, the air quality effects should be considered. A related type of action is one in which employers subsidize transit costs of their employees.

SITING/DESIGN REQUIREMENTS

Excess condemnation: Where a street or highway is to be built, an extra strip beside the roadway may be acquired for public purposes, provided that such taking complies with legal requirements. Public purposes may include passive and active recreation, visual improvement, noise abatement, and air quality enhancement, i.e., buffering adjacent land uses from excessive carbon monoxide and lead concentrations. Park-Presidio Boulevard in San Francisco illustrates the kind of development possible where multiple purposes are considered in highway planning. (The concept of excess condemnation for a buffer zone can also be applied to a sewage treatment plant with regard to odor impacts.)

E. Dust Control Mitigation Associated with Construction

1. During clearing, grading, earth moving or excavation:
 - a) Water trucks or sprinkler systems to be used in sufficient quantities to prevent dust raised from leaving the site.
2. After clearing, grading, earth moving or excavation is completed:
 - a) Seeding and watering until grass cover is grown.
 - b) Spreading soil binders.
 - c) Wetting the area down, sufficient to form a crust on the surface with repeated soakings as necessary to maintain the crust and prevent dust pick up by the wind.
 - d) Other methods approved in advance by the Air Quality Management District.
3. During Construction:
 - a) Water trucks or sprinkler systems to be used to keep all areas of vehicle movement damp enough to prevent dust raised from leaving the site.
 - o As a minimum, this will include wetting down such areas in the late morning and after work is completed for the day.
 - o Increased watering frequency will be required whenever the wind speed exceeds 15 mph.

- b) All roadways, driveways, sidewalks, etc., should be paved as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used.

4. Activation of Increase Dust Control Measures:

The contractor or builder shall designate a person or persons to monitor the dust control program and to order increased watering, as necessary, to prevent transport of dust offsite. Their duties shall include holiday and weekend periods when work may not be in progress.

(Source: Santa Barbara County Air Quality Attainment Plan, 1979.)

F. Mitigation Benefits

Most of the mitigation measures discussed, for projects and for plans, have the purpose of minimizing, or at least reducing, vehicular traffic and the air contaminants generated thereby. It is often difficult to quantify the benefits to be derived from the implementation of mitigation measures, but these GUIDELINES recommend that an attempt be made in plans and environmental impact documents.

The benefits, in terms of localized carbon monoxide emissions, are roughly in direct proportion to the reduction in vehicular miles travelled (VMTs). (Thus a project which is estimated to generate 1,000 less VMTs per day because of mitigation measures, out of 10,000 VMT per day predicted without mitigation measures, would have a decrease of roughly 10% in the CO level attributed to the project.)

The amount of reduction from any one type of measure can, of course vary greatly. Below are some estimates of localized contaminant reductions (carbon monoxide and, to some degree, particulates) as compiled from studies by the U.S. Department of Transportation and the California Air Resources Board and the Metropolitan Transportation Commission.

TABLE IX-F-1. MITIGATION BENEFITS

	<u>Estimated VMTs/Localized Emission Reduction</u>
Compressed work week (4-day/wk)	14% ¹
Flex-time	2% ²
Car-pools	1 - 5% ³
Van-pools	3 - 8% ³
Bicycling-to-work (2.5% of vehicle trips by bicycle)	3%
Employer-sponsored multi-faceted programs	up to 13%
Transit subsidies	2 - 5%
Transit improvements and preferential treatment	7%
Traffic-flow modifications	1 - 4% ⁴
Auto-restricted zones	5%
Parking fee increases	4 - 7% ⁵
Increased bridge tolls	1 - 5%
"Compact Growth Scenario" ⁶	11%

-
1. If all major employers participate.
 2. Can also spread emissions over a longer period, reducing peaks.
 3. Can be more, if employer sponsored and centrally organized and preferential parking is included.
 4. Emissions reduced though VMTs constant.
 5. If near project and increases are substantial.
 6. Long-term, comprehensive, area-wide measures to avoid sprawl and increase transit accessibility (MTC Tech Memo 22, Nov. 1977).

Note: Except for "Compact Growth Scenerio", estimated emission reductions are based on: U.S. DOT "Cost and Effectiveness...", August 1981.

X. PLAN RELATIONSHIPS

A. The Bay Area Air Quality Plan

The Bay Area Air Quality Plan has been prepared jointly by the Association of Bay Area Governments (ABAG), the Metropolitan Transportation Commission (MTC) and the Bay Area Air Quality Management District (BAAQMD). This regional plan becomes part of the State Implementation Plan (SIP), approved and integrated with other air quality plans from other California regions and counties, by the California Air Resources Board (ARB). The SIP is then forwarded by ARB to the U.S. Environmental Protection Agency (EPA), which has final approval powers. The process, then, might be seen as a classic example of federalism. Implementation is done largely through federal, state and regional actions.

But a number of critical determinants of air quality are related to such issues as distribution of population and employment growth. In the absence of strong regional control, these patterns are largely conditioned by decisions of city and county governments and by developers.

The current regional plan is the 1982 Bay Area Air Quality Plan. It explains why the region is currently classified as "non-attainment" for carbon monoxide and ozone. The State of California 24-hour average standard for particulates is also sometimes exceeded. The Plan estimates that attainment of all national Ambient Air Quality Standards (AAQS) will be reached by 1987--if all planned measures of control are implemented and if trends are as predicted, including population and employment trends estimated by ABAG and transportation services in use as predicted by MTC. Annual reports are issued and a plan update is expected in 1985. It should again be emphasized that city and county growth, in conformity to the plan, is critical to attainment of standards.

Motor vehicle emissions are regulated by the Federal Government and, even more stringently, by the State of California. Industrial and other direct source emissions are regulated under the permit processes of the Bay Area Air Quality Management District.

REGIONAL AND SUB-REGIONAL RELATIONSHIPS

Part of the air pollution problem in an inland city is caused by factors outside the city's control. Ozone levels measured will be generated by precursor emissions upwind. Under appropriate meteorological conditions, hydrocarbons and oxides of nitrogen emitted in the industrial belts along the Bay and Carquinez Strait, and automobile emissions from an even more extensive area, can contribute to ozone formation downwind. On the other hand, carbon monoxide and particulate matter affecting a city are usually generated locally by motor vehicle traffic. Particulate concentrations may also be affected by local construction, demolition, agriculture, etc. The other major criteria pollutant for which State and national ambient air quality standards have been established is sulfur dioxide. This pollutant is associated primarily with heavy industry and is not expected to be a problem in

cities distant from heavy industry. Regional and sub-regional relationships affecting air quality are especially significant in a city which is functionally and meteorologically a critical part of a complex and rapidly changing area.

CONFORMITY ASSESSMENT

Section 176(c) of the Clean Air Act requires that federal funding or approval be denied to any activity which does not conform to the 1982 Air Quality Plan. Also, no metropolitan planning organization can approve any activity which does not conform to the 1982 Plan. Section 316 of the Clean Air Act permits the United States Environmental Protection Agency to withhold, condition or restrict sewage treatment grants if an area does not implement an EPA-approved State Implementation Plan (SIP). The Bay Area Air Quality Plan is part of the California SIP. Such restrictive measures would be implemented at the Bay Area regional level with the participation of such agencies as ABAG, MTC and BAAQMD.

Conformity assessment in the Bay Area is measured quantitatively in terms of population and employment projections. These became the basis for emissions estimates and other factors which went into the Air Quality Plan. The population and employment projections were made by ABAG and are contained in the publication PROJECTIONS 79. These are updated in the publications PROJECTIONS 83 and PROJECTIONS 85, and will be updated again periodically.

Such projections are planned targets of population and employment numbers in the sense that local planning agencies have made their inputs in the regional process. Thus the projections are as close to regional planning targets as can be derived in the Bay Area situation. While the figures are broken down by county sub-areas, ABAG cautions those who would use the projections. ABAG explains that recent projections have been extremely close to reality for the Bay Area as a whole. However, the smaller the sub-unit, the less reliable the projection.

In effect, BAAQMD and other regional agencies would find a project or a plan--whether it is federally funded or not--to be of significant (adverse) environmental impact if the estimated population or employment produced, or the cumulative effect with other projects, would be significantly above the projections used as a basis for the Bay Area Air Quality Plan. (See also: Chapter VIII, Section VIII-B, Test 5.)

B. Toward an Air Quality Element of a Local General Plan

An air quality element can be formulated as an integral part of a local general plan. While this progressive idea is most relevant on the county-wide or sub-regional level, cities can also benefit by such a step, especially where they are subject to rapid growth and change.

Such integration has the potential to produce a significant input to the planning process and yield a more comprehensive guideline than the traditional ex-post-facto environmental impact report. Carefully integrated with

the other elements of the general plan, an air quality element can be used in the preparation of subsequent specific area plans, environmental impact reports on projects and other relevant planning materials.

We believe that an air quality element of a local general plan should be both a broad policy statement and, to the degree feasible, a detailed quantitative and geographic-area-specific analysis and plan guideline. It is the specific guideline characteristics which would make the element a "master document" usable in subsequent analyses and plans. A master planning or environmental assessment document may preclude the need for general material in subsequent reports based on it, in the area of its coverage. The subsequent reports would thus include only project-specific information not covered in the master. The District philosophy is that air quality concerns should be an early input into the planning process. We would rather see an EIR, with an air quality section, on a plan than on a development project. We would much rather see the plan itself, with air quality concerns expressed as planning constraints, than an ex-post-facto environmental document.

SUGGESTED ISSUES TO BE COVERED IN A LOCAL AIR QUALITY ELEMENT

Each plan air quality element should contain:

- Goals of such an element in terms of the environmental quality and health of the community. Presumably, one major goal would be achievement of all ambient air quality standards, with target dates. Odorous, hazardous and/or nuisance air pollutants might also be treated.
- Regional and sub-regional relationships concerning air quality, including relationship to the federally approved Bay Area Air Quality Plan.
- Background conditions and environmental data base--
 - o Local and regional meteorological influences on air quality.
 - o Air quality profile; historical experience, background levels, and projections of pollutant levels. Examine ozone (and its precursors), carbon monoxide, particulate matter, and sulfur dioxide.
 - o Emissions inventory data; list of stationary sources of air contaminants in and near the community (plant and area sources).
 - o Indirect sources; traffic and traffic projections, city-related and through-traffic.
 - o Sensitive receptors in the city and nearby.
 - o Odor concerns.

- o Air toxics concerns; intermedia (water, solid waste) contributions to air toxics, potential for air toxics from existing and proposed industry.
- General Plan and development program alternatives--
 - o Relationship to other elements of the general plan (see below)
 - o Air quality impact projections at build-out and during each year development phase (description of models used and results of analyses).
- Significance of analyses vis-a-vis ambient air quality standards--
 - o Expected improvement or conservation of air quality.
 - o Expected exceedances of standards.
- Mitigation measures (see Chapter IX, Section IX-D)--
 - o for mobile sources,
 - o for stationary sources,
 - o within city, beyond city borders,
 - o commitments to implementation, institutions involved.

PLAN RELATIONSHIPS

A local general plan air quality element should relate to:

- Other elements in the local general plan--especially the circulation, land use, housing (including jobs/housing balance), transportation and transit (optional), and, possibly, the conservation element (of which it could become a part). If there is an industrial and commercial development element, this should also be related. Build-out levels of the plan and phasing should also be related.
- Local regulations regarding implementation, such as zoning, use permit regulations, conditions, covenants & restrictions, development agreements, parking requirements, transportation systems management measures and the like.
- The Bay Area Air Quality Plan (The 1979 and 1982 plans have a regional focus, however some city-specific matters are also discussed).
- Environmental impact reports and statements on former and subsequent city, district or neighborhood plans and projects.
- The sub-region around cities as planned by counties and other cities, including already programmed and contemplated projects.

IDEAL DEVELOPMENT

Regarding avoidance of pollution from indirect sources (especially carbon monoxide), a careful balance in density of development should be the goal. The ideal development is one which is dense enough (or part of a compact community pattern) to make service by public transportation feasible, while not so dense that the amount and congestion of vehicular traffic generated will cause an exceedance of carbon monoxide standards.

CARBON MONOXIDE

For most cities, we suggest that one of the most important steps to take would be to document existing maximum levels of carbon monoxide and track changes in these levels over time. This would provide a valuable indicator of growth effects on air quality. It would also be very beneficial to measure CO background levels in the area. This can be done through continuous monitoring, in order to establish worst-case conditions. If continuous monitoring is not feasible, "hot spot" monitoring during worst-case conditions could be a suitable alternative.

Measured levels can be projected into future years through modeling, with appropriate estimates of future traffic conditions and motor vehicle emission factors. Spatial variations in background levels should be assessed if more than one monitoring instrument can be utilized. Experience with CO measurements in the region would suggest that concerns be focused on the 8-hour observation. We expect that worst-case 8-hour CO values will be fairly uniform over any single developed area. One-hour values can be expected to vary significantly with time and location and exhibit attainment of the standard in most situations.

FOLLOW-UP

Within reasonable limits imposed by priority commitments and work schedules, the BAAQMD Planning Division is prepared to review and assist in the development of an air quality element of the general plan.

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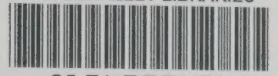
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